Clemson Graduate School Catalog, 2000-2001

Clemson University

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Clemson University
Graduate School Announcements 2000-2001
FALL SEMESTER 2000

Orientation
Late registration
Convocation
Last day to register or add a class
Last day to drop a class or withdraw from the University without a W grade
Last day to order diploma for December graduation
FALL SEMESTER 2001

Orientation
Late registration
Convocation
Classes begin; late enrollment fee applies
Late day to register or add a class
Last day to drop a class or withdraw from the University without a W grade
Last day to order diploma for May commencement

SPRING SEMESTER 2001

Orientation
Late registration
Classes begin; late enrollment fee applies
Last day to register or add a class
Last day to drop a class or withdraw from the University without a W grade
Last day to order diploma for May commencement

MAYMESTER 2001

Early registration and first day of class
Late day to register; late enrollment fee applies
Last day to drop a class or withdraw from the University without a W grade
Classes meet
Last day to drop a class or withdraw from the University without final grades
Examinations

FIRST SUMMER SESSION 2001

Late registration
Classes begin; late enrollment fee applies
Last day to register or add a class
Last day to drop a class or withdraw from the University without a W grade
Last day to drop a class or withdraw from the University without final grades
Last day to order diploma for August graduation

SECOND SUMMER SESSION 2001

Orientation
Late registration
Convocation
Classes begin; late enrollment fee applies
Last day to register or add a class
Last day to drop a class or withdraw from the University without a W grade
Last day to order diploma for May commencement

FALL SEMESTER 2001

Orientation
Late registration
Convocation
Classes begin; late enrollment fee applies
Late day to register or add a class
Last day to drop a class or withdraw from the University without a W grade
Last day to order diploma for May commencement

SPRING SEMESTER 2002

Orientation
Late registration
Classes begin; late enrollment fee applies
Late day to register or add a class
Last day to drop a class or withdraw from the University without a W grade
Last day to order diploma for May commencement

Note: Dates on this calendar were accurate at the time of printing; however, they may change as conditions warrant. Current information is available on the Web at www.registrar.clemson.edu/publiccatalog/calendar.htm.
DEADLINE DATES

For those who expect to receive a graduate degree on:
December 21, 2000  May 11, 2001  August 11, 2001

Last day for:

- Submitting Form GS2, Graduate Degree Curriculum, to the Graduate School. *
  August 12, 2000  December 21, 2000  May 11, 2001
- Submitting Form GS4, Application for Graduation and Diploma Order, to the Graduate School. †
- Ordering cap, gown and hood from the University Bookstore.
- Taking of oral and/or written examination (GS7).
  November 21, 2000  April 20, 2001  July 20, 2001
- Final review and approval by the Graduate School of completed and signed theses and dissertations.
- Submission of duplicated copies of theses and dissertations to the Graduate School and date at top of Approval Page.

* 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 adviser and advisory committee (see page 27).
☐ Submit Graduate Degree Curriculum (Form GS2) (see page 27).
☐ Satisfy any prescribed language requirement and comprehensive examination prerequisite for admission to candidacy (see pages 30–33).
☐ Complete final examination (Form GS7)(see page 31).
☐ Apply for admission to candidacy for a doctoral degree (Form GS5)(see page 27).
☐ Order diploma (Form GS4) after completing at least half the prescribed course work (see page 28).

☐ Order cap, gown and hood from the University Bookstore.
☐ Submit completed thesis (if required) or dissertation to research adviser and arrange for final examination by the advisory committee (see pages 33–34).
☐ Arrange for approval of thesis or dissertation by the Graduate School prior to duplication (see page 33).
☐ 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 34).

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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(1) = 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 Mechanic, 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 assayer 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 also was 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 homeplace, 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 1955, 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 16,982 for the first semester 1999-00. In addition to students from virtually every state, Clemson has approximately 850 enrolled students from 73 nations. Since the opening of the University, 80,284 students have been awarded bachelor's degrees. During this same period 24,212 graduate degrees have been awarded.

Clemson currently offers 112 graduate degree programs in 72 fields of study. Included in this total are 39 doctoral, 72 master's, and one educational specialist program(s).

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. Oconee 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, AACSBB - The International Association for Management Education, Computing Sciences Accreditation Board, Council on Architectural Accreditation, 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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ENROLLMENT OPPORTUNITIES
On-Campus Enrollment
Total enrollment for the fall semester of 1999 was 16,982. Of this number, 3,456 were graduate students. Approximately 1,851 were classified as full-time graduate students and 1,605 as part-time students. The number of male graduate students was 1,792, and 1,664 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 (with MUSC)
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.

Telecampus
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 Sirrine Hall, Clemson, SC 29634-5121; or by calling 1-888-CLEMSON (1-888-253-6766), (864)656-4227 in the local area, 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:

1) The student's state of legal residence must be AK, AL, DE, FL, GA, KY, LA, MD, MS, OK, TN, TX, VA or WV. 2) The desired program of study must be the Ph.D. program in industrial/organizational psychology, or 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 applied psychology, applied sociology, architecture, textile science, packaging 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 (MPRTM). 3) The Coordinating Board in the state of the student's legal residence must have selected the program 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 - Fri-
day 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 is closed on all University holidays. If necessary, call (864) 656-4789 for more specific information on operating hours.

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 nonprofit 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 39 doctoral, 72 master's and one educational specialist degree(s) across 72 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:
- assist in recruitment and retention of a diverse group of scholars;
- maintain uniformly high standards across all programs and evaluate degree programs;
- 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 dismissals 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 Holaday, 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
Diane Donald, Information Technology Consultant

Graduate Fellowships and Assistantships
Brenda J. Goodman
Sandra Witt

Graduate Admissions
Kay Reckley
Jerry Courtney
Jan McCracken
Ann Ruckle-Mauldin
Shirley Grimes
Sharon Miller
RESEARCH AND GRADUATE STUDIES
Sponsored Programs Office
Founded as a land-grant college dedicated to expanding the frontiers of knowledge 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. Ap-
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 part-
nerships 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 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 better to 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.

In June of 1999, Raymond Don Rice was appointed Director of the Brooks Institute. Mr. Rice has over 20 years experience in the areas of Motorsports, Golf and Thoroughbred Racing. Mr. Rice has added golf and equine sports to the motorsports emphasis of the Institute and will expand into other non-traditional sports as time and opportunities arise.

Since beginning as Director of the Brooks Institute, Mr. Rice has secured research programs with Michelin Tire Company, Kentucky Motor Speedway, and NASCAR teams. He currently is in the process of informing industry of Clemson University's prominence in motorsports as well as the other disciplines.

He has proposed programs to the thoroughbred horse industry through the use of equine drugs patented by Clemson University that will make a major impact on that industry. Mr. Rice is on the Clemson University committee that has proposed a Professional Golf Management School sanction from the PGA. He has obtained commitments from golf industry partners for their employment of graduates of that program. Other motorsports programs initiated will be announced in the near future.

Center for International Trade (CIT)
The Center for International Trade (CIT) is Clemson's newest research center. Established by the South Carolina Commission on Higher Education in 1999, its mission is to support teaching, research and outreach activities pertaining to international trade at Clemson University and throughout the state, region and nation. The CIT serves as the home for a wide range of interdisciplinary initiatives designed to: (1) enhance the education of Clemson students; (2) foster research on important issues and policies pertaining to international trade; and (3) increase the competitiveness of partners in business and industry by improving their effectiveness in conducting international trade activities. Specific objectives of the CIT are:
• to promote a significant level of integration of issues and perspectives pertaining to international trade and the global economy in the academic programs offered within the university;
• to foster and support relevant scholarly research on international trade; and
• to cultivate partnerships with business and industry and with government organizations that support the expansion of international trade as a means of enhancing economic development within the state of South Carolina and the nation.

Teaching Mission
College graduates in all disciplines increasingly face the prospect of employment by companies that engage in international trade. To prepare students to carry out their professional responsibilities in a global environment, Clemson University must ensure that they are systematically exposed to international perspectives throughout the curriculum. The CIT is a major catalyst for the University's efforts to further this essential academic objective. To promote Clemson University's mission of infusing a global perspective in the curriculum, the CIT facilitates the development of course modules for existing courses and new courses that focus on international trade and the global economy.

Research Mission
The CIT serves as the focal point for fostering and supporting interdisciplinary research on all aspects of trade in the global economy. Drawing on expertise throughout the University, the CIT strives to cultivate opportunities for faculty and students to address questions and problems pertaining to international commerce. The center's research focuses on such topics as international market analysis; assessing resources in South Carolina that can be used to expand international trade; trade policies, regulations, and barriers; and economic development through international trade. An important thrust of the CIT is seeking external funding for its research projects.

Outreach Mission
The CIT aims to promote economic development in South Carolina by exploring opportunities for international trade, assisting firms attempts to enter interna-
tional markets, and helping companies prepare for the challenges of operating in the global economy. These objectives are met in part through collaboration with a number of significant organizations that are involved in promoting international trade for South Carolina companies. These include the South Carolina Department of Commerce, the South Carolina Export Consortium, the Upstate Trade Council and similar organizations across the state, World Trade Centers, and other colleges and universities in the state. Pursuing the outreach mission of the CIT provides a host of clinical experiences for students and faculty, while addressing the needs of South Carolina business firms.

The CIT is also active in fostering professional dialogue about issues pertaining to international trade. Through its sponsorships of seminars, symposia, and professional conferences, the CIT brings together representatives from diverse international communities to present research and exchange ideas about conducting business in the global economy. An example of this is the Bank of America/Clemson Global Forum, which is supported by a major gift to Clemson University from Bank of America.

Currently participating in the center are members of the faculties of the College of Business and Public Affairs; the College of Agriculture, Forestry and Life Sciences; the College of Engineering and Science; and the College of Architecture, Arts and Humanities.

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 photocopying. 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. Some 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 services 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
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 www.grad.clemson.edu/. Applicants may check the status of their application at this same Internet address.

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 these dates. The actual application 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* via money order or 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 is also required within the past year. Students not in compliance with immunization requirements will not be allowed to complete registration.

Disposition of Application Materials

Credentials or supporting materials submitted for admission to the Graduate School become the property of the Uni-
versity and are not returned. Furthermore, no copies will be provided to a third party outside the University even if the applicant requests this release. Copies will be provided to appropriate offices at the University in the interest of academic matters or financial awards relative to the applicant.

**Appeal 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 general portion of the Graduate Record Examinations (GRE)**. Applicants to the M.S. degree program in industrial management must submit satisfactory scores on the Graduate Management Admission Test (GMAT)**. Applicants to the master’s program in economics and the Ph.D. degree program in industrial management may submit satisfactory scores on the GMAT** in lieu of the GRE.

2. **The Professional Degrees.** Admission criteria, recommended by the individual colleges awarding the degree, may include professional experience and/or credentials as well as GRE general scores.** Specifically, the professional programs in accounting, business administration and health administration require satisfactory scores on the GMAT**.

International students, in addition to meeting the minimum and general requirements stated previously, must submit satisfactory scores on the general portion of the Graduate Record Examinations** regardless of the degree objective. (However, see items 1 and 2 above for the master’s programs in industrial management, accounting, business administration and health administration.) A satisfactory score on the Test of English as a Foreign Language (TOEFL)** is also required of international students whose native tongue is not English. Applicants who hope to receive a graduate assistantship are encouraged to submit scores from the Test of Written English (TWE) administered simultaneously with the TOEFL at most test locations. The Graduate School may waive this requirement if the applicant has a demonstrated command of the English language.

Admission to all programs is restricted to those students whose academic records indicate the potential to be successful in graduate studies. This determination is made by the faculty of each graduate program and is affirmed by the Graduate School. This determination may include a broad range of performance indicators, and these indicators may be different for master’s and doctoral programs in the same discipline. The indicators may include (but are not limited to) previous academic (both graduate and undergraduate) performance, standardized test scores, letters of recommendation, personal interviews, applicant statements of interest, a portfolio of previous work and materials indicating the applicant’s ability to perform independent research in the discipline. The faculty of each program has significant discretion to annually determine admission standards and class size based on availability of academic advisers, financial support, laboratory space, student distribution within interest areas and other resource constraints. 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 to the Graduate School 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 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 a new application to the Graduate School. An application fee is not required if the application is received within one year of completing the initial degree.

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.

**Readmission**

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.

**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.**
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 difficulty 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.

**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 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 17).

In addition to meeting the minimum and general requirements for admission listed under "Academic Requirements" (see page 15), 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 Student 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 $636* per semester and $177* 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).

The MHA joint degree program agreement between Clemson University and MUSC does not include reduced tuition for graduate assistants working at Clemson University. No reciprocity regarding tuition remission exists within this agreement.

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.

* 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 (fall and spring semester)</td>
<td>Graduate Assistantship Fee</td>
</tr>
<tr>
<td>The first week of class (summer school)</td>
<td>Full tuition and fees (based on hours enrolled)</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>100% of tuition and fees, minus the graduate assistantship fee paid</td>
</tr>
<tr>
<td>No benefit</td>
<td>No liability</td>
</tr>
</tbody>
</table>

Academic Fees

<table>
<thead>
<tr>
<th>South Carolina Resident</th>
<th>Nonresident</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full-time Graduate Student</strong> (12 or more hours)</td>
<td></td>
</tr>
<tr>
<td>First Enrolled Prior to Spring 2000</td>
<td>$1,795*</td>
</tr>
<tr>
<td>First Enrolled Spring 2000 or After</td>
<td>$1,905*</td>
</tr>
<tr>
<td>Payment of the above fees mandates a health fee but also provides certain entitlements. (See &quot;Related Expenses&quot;)</td>
<td></td>
</tr>
<tr>
<td>Part-time Graduate Student (less than 12 hours)</td>
<td>$180* (per hour)</td>
</tr>
<tr>
<td>Off-Campus Rates:</td>
<td></td>
</tr>
<tr>
<td>MBA Program</td>
<td>$254* (per hour)</td>
</tr>
<tr>
<td>Non-MBA</td>
<td>$202* (per hour)</td>
</tr>
<tr>
<td><strong>ALL STUDENTS</strong> (excluding Graduate Assistants): Laboratory Fee:</td>
<td>$25* (per lab seat)</td>
</tr>
</tbody>
</table>

Academic fees for classes taught out-of-state or out-of-country are determined on the basis of location. Special fees apply to the joint MHA degree administered between Clemson University and MUSC. Contact MHA program coordinator for specifics.

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) $180.*
- 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).

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:

Graduation Fees

The following graduation fees are in addition to the above charges:

- Diploma Case $8*
- Diploma Mailing Fee $4*
- Apparel for Graduation (attendance optional) $54.00*
- Ph.D. Degree Candidates $55.00*

Binding fees for theses or dissertations, 3 copies required ($10* for each copy up to 5, $15* for each copy above 5*)

Mailing Thesis/Dissertation
- US Mail $4* per copy
- International Mail $6* per copy

Publication of Dissertation
- Abstract (if applicable) $55*

Costs for preparation and duplication of the thesis, dissertation or departmental project report, as well as binding fees for personal copies, are extra charges to be borne by the student.

RELATED EXPENSES

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.

* Subject to change.
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 Jervey 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.

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 $48* for one year, August 15 to August 14, 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. 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 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 found to be in default on payments of student loans will be subject to wage withholding (garnishment) according to Legislative Authority P.L. 102-164; 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, in writing, 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

*Subject to change.
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 (Graduating)” on page 28), special examinations and research efforts.

The Southern Association of Colleges and Schools (SACS) requires that all Graduate Teachers of Record (GTR) have “earned at least 13 graduate semester hours in their teaching discipline, be under the direct supervision of a faculty member experienced in the teaching discipline, receive regular in-service training and be evaluated regularly,” (Section 4.8.4 of the SACS Criteria for Accreditation).

The Department Chair has the responsibility for determining that the 18-hour requirement is met either through course work or with a memo containing documentation that the graduate assistant meets the requirement as an exception. Graduate School staff will check the GS2 form and/or memo and certify that the 18-hour requirement has been met.

**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 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 assistantship appointments should be agreed upon in writing by the student and the immediate faculty adviser 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**

All appointments for assistantships (teaching, research, laboratory, administrative and grader) must be processed on the Graduate Assistantship Tuition Remission. All Graduate Administrative and Graduate Extension Assistantships (new and continuing) must be approved by the Graduate School before they are offered to the students for Fall 2000. Work assignments for students should be as specific as possible and should be developed to reflect the relationship to the student's academic program. The work to be performed must also be above the paraprofessional level. Administrative units hiring Graduate Administrative Assistants will need to form a partnership with an academic department or departments. Two signatures will be required: (1) the employing supervisor and (2) the student’s academic adviser. The department shall provide a brief descrip-
tion 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 Academic Grievance Committee (see page 35).

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.

4. Termination of Assistantship because of Unexpected Loss of Research Funding. A sudden or unexpected loss of external funding may result in a termination of an assistantship. The policy described below will be used to calculate any tuition and fees required by a graduate student. A department chair may request an exception to the policy with appropriate documentation. (See "Graduate Assistantship Prorata Tuition Policy" on page 18.)

International Student Employment and Financial Assistance

Financial assistance is available to Clemson's international graduate students through instructional and research assistantships. Assistantships are awarded by individual departments, and the student must contact the department directly regarding the availability of assistantships. The department will notify the student only in the event of an awarded assistantship. Applicants who hope to receive assistantships must submit satisfactory scores on the Test of English as a Foreign Language (TOEFL) and the Test of Written English (TWE).

Special employment regulations for international students are determined by the Immigration and Naturalization Service (INS). To ensure compliance with these regulations, international students must obtain permission from the International Office before gaining employment at Clemson. Nonacademic employment opportunities are available on campus on a first-come basis. Applications are made directly to the hiring source upon arrival on campus. Off-campus employment generally is unavailable to international students and should not be considered as a means of support. Application for practical training and certain other categories of employment may be made after one academic year. Further information is available in the Office of International Services and Diversity Programs (ISDP), E-208 Martin Hall, telephone (864) 656-2357.

Hourly Employment

Employment on an hourly basis for a portion of a semester or session is possible in some departments. The maximum credit load is the same as that for graduate assistants found under "Enrollment Limits" (see page 29). Enrolled graduate students (exclusive of full-time University employ-

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 redeem 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 midpoint 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 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 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, the refund is 100 percent. Beginning with the day following the last day to register, refunds for periods of four weeks or less during a semester shall be made on the schedule shown below.

<table>
<thead>
<tr>
<th>Period of Enrollment after Last Day to Register</th>
<th>Percent Refunded</th>
</tr>
</thead>
<tbody>
<tr>
<td>One week or less</td>
<td>80%</td>
</tr>
<tr>
<td>More than 1 but not more than 2 weeks</td>
<td>60%</td>
</tr>
<tr>
<td>More than 2 but not more than 3 weeks</td>
<td>40%</td>
</tr>
<tr>
<td>More than 3 but not more than 4 weeks</td>
<td>20%</td>
</tr>
<tr>
<td>More than 4 weeks</td>
<td>0%</td>
</tr>
</tbody>
</table>

Summer Session. No refunds of academic and medical fees will be made after three weeks from the last day 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 students who drop credit hours will be based on the date the course is dropped. To be eligible for 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, the refund is 100 percent. Beginning with the day following the last day to register, refunds for summer school sessions shall be made on the schedule indicated below.

<table>
<thead>
<tr>
<th>Period of Enrollment after Last Day to Register</th>
<th>Percent Refunded by Length of Summer Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>One week or less</td>
<td>More than 3 wks. 6 wks. 6 wks.</td>
</tr>
<tr>
<td>More than 1 but not more than 2 weeks</td>
<td>0% 0% 0%</td>
</tr>
<tr>
<td>More than 2 but not more than 3 weeks</td>
<td>0% 0% 0%</td>
</tr>
<tr>
<td>More than 3 weeks</td>
<td>0% 0% 0%</td>
</tr>
</tbody>
</table>

Establishment of University Fees

The annual State Appropriation Act imposes the general requirement that student fees be fixed by the University Board of Trustees. The act imposes two specific requirements on the Board:

1. In fixing fees applicable to academic and general maintenance and operation costs, the Board must maintain a minimum student fee not less than the fee charged the previous year;

2. In fixing fees applicable to dormitory rental, dining halls, laundry, infirmary and all other personal subsistence expenses, the Board must charge students an amount sufficient to cover fully the cost of providing such facilities and services.

*Subject to Change
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 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 cost 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 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, as defined in section 59-112-10 above, of an independent person who is domiciled in this state; or if such dependent is claimed as an income tax exemption by 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 charges shall be adjusted as follows:

A. Except as provided in section 59-112-20 above, when domicile is taken in South Carolina, a student shall not become eligible for in-state rates until the
been domiciled

service personnel are ordered

for an additional

intention by the parties to
dependents may be considered eligible for in

Except a

11 member

charged, if they have evinced an intent
to establish domicile in South Carolina

and if they have resided in South Carolina

to make an application for, or to receive

Effect of marriage—section 59-112-40

Except as provided in section 59-112-20

residence classification of applicants. The

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 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.

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 provision 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 59-112-10a 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.

Code of laws governing residence—section 62-601. 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 abandoned all prior domiciles and 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 dependents 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 that 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. "Continuous 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. Steps 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 provides 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.

Nonresidents—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 parolees 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 towards the twelve month residency period. Certain nonresident aliens present in the United States in specific visa classifications 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 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.

B. 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, indica as listed below. The absence of indica in other states is required before the student is eligible to pay in-state rates. Indica 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 indica 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 resi-
SOUTH CAROLINA RESIDENCE REQUIREMENTS

dence 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 that 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 change of residency—section 62-607.
A. Notwithstanding other provisions of this section, any dependent person, except as otherwise excluded, who has been domiciled with his/her family in South Carolina for a period of not less than three years immediately prior to enrollment at state-supported colleges and universities may enroll in those institutions of higher learning at in-state rates and may continue to be enrolled at such rates even if the person upon whom he/she is dependent moves his/her domicile from this state.
B. If a dependent or independent person has been domiciled in South Carolina for less than three years, eligibility for in-state rates shall end on the last day of the academic session during which domicile is lost.

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 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 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. Dependents 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 domiciliary"). 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.

### 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 adviser 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 Adviser**

A student, with the aid and approval of the department chair or program coordinator, must select a major adviser. This adviser 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 adviser. This adviser 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 adviser 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 adviser, 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 pursuing a graduate degree. Rather, it is an explanation of primary factors encountered during the process.

**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.**

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**An academic semester is defined as a minimum of nine credit hours of course work not graded pass/fail. An academic year is defined as the total of two academic semesters.**

**Subject to change.**
mission 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 are counted toward the number of credit hours required for the degree. The accumulation of grades in thesis or dissertation research does not imply completion of the research, but indicates satisfactory progress only.

A minimum grade of C must be made on all course work to obtain graduate credit. The graduate 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. 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.

First Day Class Attendance
All students are required to attend the first scheduled day of classes and labs. Students who cannot attend the first class are responsible for contacting the instructor to indicate their intent to remain in that class. If a student does not attend the first class meeting or the last day to add, whichever comes first, the instructor has the option of dropping the student from the roll.

Class Syllabus
A syllabus will be prepared for every graduate class and made available to students as early a class meeting as practicable, but no later than the last class period before the last day for a student to add a class. It should give the course expectations, including topical outline of the course, grading policies and attendance policies.

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 be-

<table>
<thead>
<tr>
<th>Student Category</th>
<th>Semester</th>
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<th>Credit Hours 3-Week Session</th>
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<tr>
<td>Graduate Assistants (1/4 time)</td>
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<td>Persons Employed Full Time</td>
<td>6</td>
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<td>1</td>
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</tbody>
</table>

*Subject to change
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 adviser. 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 adviser 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 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.

Exceptions to this policy are rarely granted and must be approved by the graduate committee chair, department chair and the graduate dean.

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 adviser 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 audits 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 in-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" 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.

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.

M A S T E R ' S D E G R E E
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 a 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 candidates 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 adviser.

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 adviser 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 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 translation 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.

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 adviser 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 adviser, 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 appropriation 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 adviser and advisory committee as often as is deemed necessary by the committee. Further, the student may, at the discretion of the dissertation adviser 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 as necessary.

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

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 examination 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.

THESSES AND DISSERTATIONS
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 to 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 adviser, 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 revi-
sions; 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 adviser 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 adviser is obligated to initiate the thesis/dissertation review form and forward it to the remaining committee members along with the manuscript. The research adviser 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 forever. A definite term of confidentiality shall be stated in a written nondisclosure agreement and shall 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, these 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.

Copies of the policies on patents and copyrights are available in the individual departments and colleges and in the Graduate School. Any graduate student who plans to accept a research assistantship or public service assistantship is encouraged to read the policies prior to accepting the assistantship.

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 adviser 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 adviser 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.
GRIEVANCES

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.

Rules and Procedures

1. Any complaint should first be taken to the faculty or staff member involved for resolution. If no resolution is reached, the graduate student should consult with the department chair and the dean or the immediate superior of the staff member to hear the grievance and act as a referee. The student, dean of the college, department, and faculty or staff member should make every effort to reach a solution.

2. If the grievance remains unresolved, the student may bring it before the Graduate Student Grievance Committee by a written statement detailing the grievance. All issues to be grievances must be delineated in the written statement. The statement must be delivered in a sealed envelope to the Office of the Dean of the Graduate School within 60 calendar days from the date the student alleges to have been aggrieved, except in cases involving a protest of a final grade when the statement must be filed within 90 calendar days from the date on the grade report. In cases involving academic dishonesty, the Policy on Academic Misconduct shall be applied, and the grievance shall be filed within seven days from the date a written charge is made by the professor. A copy of the charge is to be given to the department chair or dean. The dean of the Graduate School (or the dean's designee) shall attempt to resolve the grievance. If no resolution is reached, then the dean of the Graduate School (or the dean's designee) shall request the graduate student in assembling the necessary information for presenting his or her complaint to the Graduate Student Grievance Committee. Failure of the student to file a grievance within the 60-day time period will result in forfeiture of the right to file a grievance under this procedure.

3. The committee will attempt to gather all pertinent information in separate meetings with all individuals able to give information concerning the grievance.

4. The Graduate Student Grievance Committee will, if at all possible, handle each case as a confidential matter.

5. The committee will formulate its findings in writing and seek to obtain signed approval for the recommend solution from all parties involved within 14 calendar days.

6. If the committee cannot obtain a solution that is acceptable to all involved 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 admi-
sion 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 39).

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 35). 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 (see page 39) 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.
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 a 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 accused 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 committee 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.

Executives Interpretation

DEFINITIONS

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 Senate and the chair of the 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 Senate and the chair of the 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 Senate and the chair of the 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 subjected to appropriate administrative sanction.

III. B. A Committee of Inquiry is responsible for determining whether the facts in the case are contentious (sufficient uncertainty exists to prevent a determination of innocence without extensive investigation), or that there is a probability that the accused's position is or is not credible.

A driving concern of the Committee of Inquiry is the protection of all involved and particularly that of the accused. Toward this end, a Committee of Inquiry should balance the need for information upon which to make a decision against the need for confidentiality, with the balance in favor of confidentiality. The merit of charges cannot always be made on the strength of charges alone, thus, to adequately protect the accused against a potentially damaging investigation, the committee may need to expand its inquiry beyond the charges and accompanying documentation. At the same time, it must be realized that the likelihood of trauma and 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 knowl-
edge 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 it may uncover 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 no 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.
GRIEVANCES

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 the 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 in 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 adviser present at the hearing; however, the role of the attorney or adviser shall be solely to assist the party, and the attorney or adviser 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 typewritten 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. The report shall contain findings and a recommendation as to whether the degree holder’s degree should be revoked. The Committee of Investigation and Recommendation must find clear and convincing evidence that serious academic misconduct has been committed in order to recommend the revocation of the degree holder’s degree. If the Committee of Investigation and Recommendation does not find clear and convincing evidence of serious academic misconduct, the Committee of Investigation and Recommendation cannot recommend revocation of the degree holder’s degree and the matter shall be closed. Note: A majority vote of the Committee of Investigation and Recommendation is necessary to recommend the revocation of a degree holder’s degree. This means that a tie vote will result in the matter being closed.

At the same time that the report is sent to the vice president for academic affairs and provost, the chair of the Committee of Investigation and Recommendation shall send a copy of the report to the degree holder, the dean and other appropriate persons involved in the process.

If the Committee of Investigation and Recommendation recommends that the degree holder’s degree be revoked, the chair shall also send a complete copy of the
I ate and degree held, or degree held in a degree earned by the Board of Trustees at the request of the graduate student, 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.

I N T E R N A T I O N A L S E R V I C E S

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 advisers, 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, Michelin® 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 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 USA 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 USA requirements, with securing insurance and with issues that may involve the sponsoring department or visitor's government.

The study abroad adviser 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.

**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.

**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 (rubeola) 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, sexuality, 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 lifestyles 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. 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 Schillletter dining halls feature an unlimited seconds policy, except on selected entrees, while Clemson House dining room, Canteen and Fernow Street Cafe serve meals on an a 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. Lil' Dino Subs and Taco Bell Express are located at the East Campus Convenience Store; Chick-fil-A is located at the Union Canteen; Pizza Hut Express is at the Fernow Street Cafe; and Burger King, Lil Dino's, Freshens and Chicken and Biscuit are located in the Hendrix Center. 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 may choose a meal plan on a semester basis or pay for individual meals. Meal plans include: Unlimited Access, Any 15, Five-Day, Plus Any 15, Plus Any 10, or Any 10. 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 compli-
POLICY ON SEXUAL HARASSMENT

Title VII of the Civil Rights Act of 1964, as amended, provides that it shall be unlawful discriminatory practice for any employer, because of the sex of any person, to discharge without just cause, to refuse to hire, or otherwise discriminate against any person with respect to any matter directly or indirectly related to employment. Harassment of any employee on the basis of sex violates this federal law. The Equal Employment Opportunity Commission has issued guidelines as to what constitutes sexual harassment of an employee under Title VII.

Unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature constitute sexual harassment when the following occurs:

1. submission to such conduct is made explicitly or implicitly a term or condition of an individual's employment or academic standing; or

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 a claim of sexual harassment arises, 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, 636-3181, for advice and assistance in resolving complaints.

In the event a graduate student wishes to appeal the resolution of the Office of Access and Equity, the student must submit a written request for an appeal to the Dean of the Graduate School who in turn will convene an ad hoc committee that will review the process and/or sanction. The committee membership will come from faculty and students already appointed to the Graduate Council.

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 activities. The salient features of the policy as they directly affect students are as follows:

A student who experiences difficulty with the instructor’s written or oral English and who wishes to seek relief must so prior to the seventh meeting of a 50-minute class and prior to the fifth meeting of a 90-minute class in regular semesters. In the five-week summer sessions, relief must be sought prior to the third class meeting.

Students are to initiate the grievance by coming to the Office of the Director of Undergraduate Academic Services (101 Sikes Hall) and receiving the grievance instructions with the time limits set above.

DIRECTORY INFORMATION POLICY

Clemson University hereby designates the following categories of student information as public or "directory information." Such information may be disclosed by the institution for any purpose, at its discretion.

Category I

Name, local mailing address, home address, local phone number, residence hall and room number (if applicable), major course and academic class.

Category Ia

Dates of attendance, degrees awarded, date and place of birth, major course and academic class.

Category II

Participation in officially recognized activities and sports.

Category III

Physical factors (height, weight of athlete), date and place of birth for members of athletic teams.

Currently enrolled students may withhold disclosure of any category of information under the Family Educational Rights and Privacy Act of 1974. To withhold disclosure, written notification must be received in the Registration Services Office by the last day to register for the enrollment period concerned as published in the Clemson University calendar at Clemson University, Clemson, South Carolina 29634-5125. Forms requesting the withholding of directory information are available in the Registration Services Office, E203 Martin Hall.

Clemson University assumes that failure on the part of the student to specifically request the withholding of categories of directory information indicates individual approval for disclosure.

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. A school official is a person employed by the University; a person or company with whom the University has contracted (such as an attorney, auditor, or collection agent); a person serving on the board of trustees; or a student serving on an official committee, such as a disciplinary or grievance committee, or assisting another University official in performing his or her tasks. A school official has a legitimate educational interest if the official needs to review an education record in order 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 adviser, 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. Photographs, 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 (E-203 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.”
### COURSE PREFIXES

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

College of Agriculture, Forestry and Life Sciences

**School of Animal, Biomedical and Biological Sciences • 48**
Agricultural Education • 48
Animal and Food Industries • 49
Animal and Veterinary Sciences • 49
Animal Physiology • 51
Biochemistry • 53
Biological Sciences • 53
Biology Instruction • 56
Botany • 56
Genetics • 57
Microbiology • 57
Zoology • 59

**School of Plant, Statistical and Ecological Sciences • 59**
Crop and Soil Environmental Sciences • 59
Entomology • 61
Experimental Statistics • 62
Horticulture • 62
Plant Pathology • 64
Plant Physiology • 65

**School of Natural Resources • 66**
Aquaculture, Fisheries and Wildlife Biology • 66
Environmental Toxicology • 67
Forest Resources • 68

**School of Applied Science and Agribusiness • 70**
Agricultural and Applied Economics • 70
Agricultural Mechanization • 73
Applied Economics • 73
Biosystems Engineering • 74
Food Science and Human Nutrition • 74
Food Technology • 74
Packaging Science • 75
C O L L E G E O F A G R I C U L T U R E , F O R E S T R Y A N D L I F E
S C I E N C E S  William B. Wehrenberg, Dean

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
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
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 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.

SCHOOL OF ANIMAL, BIOMEDICAL AND BIOLOGICAL SCIENCES
Thomas R. Scott, Director

AGRICULTURAL EDUCATION
William Surver, Chair, Department of Biology Instruction and Agricultural Education

<table>
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<tr>
<th>Major</th>
<th>Degree</th>
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<tr>
<td>Agricultural Education</td>
<td>M.Ag.Ed.</td>
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The Master of Agricultural Education is a professional degree designed to enhance the human resource skills in agriculture and education. The flexible program provides a core of planning, delivery, evaluation and administrative strategies while encouraging specialization in teacher education, adult and extension education, agricultural communications, youth development or technology transfer. Degree recipients hold positions as agricultural teachers, extension agents, agricultural and environmental agency employees, as well as human resource development specialists in agricultural industry.

Candidates for the degree are required to:
1. plan an individual program of study in consultation with the major adviser and graduate committee;
2. complete a minimum of three semester hours in adult education, three semester hours in research methods and three semester hours in statistics;
3. complete a minimum of 12 semester hours in the major field; and
4. complete a minimum of six semester hours in a concentration outside the major field.

A minimum of 30 semester hours is required for the professional degree. At least one-half of the credit hours in the student's program must come from courses numbered 700 or above. The student's program of study must be approved by his or her advisory committee.

AG ED 601: Methods in Agricultural Education, 3 cr. (2 and 3) F
Appropriate methods of teaching vocational agriculture in high schools. The course includes procedures for organizing teaching programs, teaching high school students and directing FFA activities.

AG ED 603: Principles of Adult/Extension Education, 3 cr. (3 and 0)
Overview of adult/extension education and adult learning. Selection of adult education providers will be reviewed with emphasis on extension. Prerequisite: Junior standing or permission of instructor.

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
AG ED 631: Methods in Environmental Education, 3 cr. (3 and 0) S
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.

ED 737: Internship in Agribusiness Firms, 3 cr. (1 and 6) S
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.

ED 750: Special Institute Course: Selected Topics in Agricultural Education, 1-3 cr. (1-3 and 0) S
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.

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

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 appraising educational outcomes of student achievement and total programs. Prerequisite: Permission of instructor.

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.

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.

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) S
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
Donald Henricks, Program Coordinator, Department of Animal and Veterinary Sciences

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<tr>
<th>Major</th>
<th>Degree</th>
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<tbody>
<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 human nutrition 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>
</tr>
<tr>
<td>Animal Physiology</td>
<td>M.S., Ph.D.</td>
</tr>
<tr>
<td>Nutrition</td>
<td>M.S., Ph.D.</td>
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</table>

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 FH 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 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 2) 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 3-9)  
Selected topics of interest in AVS not covered in other courses. May be repeated for credit. Prerequisite: Permission of instructor coordinating the topic.

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 630: 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 631: 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 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 or 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, placentation, embryogenesis, embryonic-metrial 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 cytoplasmic frequency, system of mating, heritabilities, genetic consequences of selection and criteria for evaluating improvement in all domestic livestock. Prerequisite: AVS 652.
Animal physiology is a graduate program developed and offered by the Department of Animal and Veterinary Sciences. 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 BIOCH 623, EX ST 801 and BIOSC 659, 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 academic program and research emphasize a study of physiological processes, particularly those related 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 com-

mittee, to prescribe course work to correct these deficiencies. All students majoring in animal physiology are required to complete AN PH 851.

AN PH 852: 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 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 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. Prerequisite: Permission of instructor.

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 680, 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. 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 vascular 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, PS 201 or permission of instructor.

AVS 653: Animal Reproduction, 3 cr. (2 and 2) S Reproductive physiology and endocrinology of farm animals 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; effects of parity, environmental factors and reference to other mammals. Prerequisites: AVS 202 and BIOCH 210.

AVS 803: Physiology of Reproduction and Milk Secretion, 3 cr. (3 and 0) Advanced concepts of endocrinology, gametogenesis, fertilization, placentation, embryogenesis, embryonic-embryotrial 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.
BIOCH 625: 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.

BIOCH 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. Prerequisites: BIOCH 210 or organic chemistry.

BIOCH 623: Principles of Biochemistry, 3 cr. (3 and 0)
Chemistry of amino acids, monosaccharides, fatty acids, purines, and selected techniques. Prerequisites: BIOCH 52 and aspects, beginning level. Permission of instructor.

BIOCH 633: General Biochemistry Laboratory I, 2 cr. (0 and 4)
Experiments selected to illustrate current methods used in biochemical research. Corequisites: BIOCH 423 or 431.

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

BIOCH 615: 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 617: 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; endocrinopathies of hormone imbalance. Prerequisite: BIOCH 632 or permission of instructor.

BIOCH 632: Animal Histology, 3 cr. (3 and 0)
A 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: BIOCH 303 or permission of instructor. Corequisite: BIOCH 433.

BIOCH 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: BIOCH 432.

BIOCH 659: Systems Physiology, 3 cr. (3 and 0)
Physiological systems of vertebrates and their homeostatic controls; functions 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.

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 BIOCH 459. Students will be introduced to computer-aided data acquisition and computer simulations of physiological function. Prerequisite or Corequisite: BIOCH 459.

BIOCH 661: Cell Biology, 3 cr. (3 and 0)
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.

BIOCH 668: Herpetology, 3 cr. (2 and 3)
Systematics, life history, distribution, ecology and current literature of amphibians and reptiles; laboratory study of morphology, identification of world families, U.S. genera and all Southeastern species. Field trips will be required. Prerequisite: BIOCH 303 or permission of instructor.

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

BIOCH 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: BIOCH 470 or permission of instructor.

BIOCH 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: BIOCH 303 or permission of instructor.

BIOCH 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.

BIOCH 676: Comparative Physiology Laboratory, 2 cr. (1 and 2)
Modern classical experimental methods will be used to demonstrate fundamental physiological principles discussed in BIOCH 475. Students will be introduced to computer-aided data acquisition and manipulation as well as computer simulations of physiological function. Prerequisite or Corequisite: BIOCH 475.

BIOCH 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: BIOCH 303 or permission of instructor.

BIOCH 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: BIOCH 303, organic chemistry or permission of instructor.

ENT 640: Insect Behavior, 3 cr. (2 and 3) F (odd numbered years)
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.

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.

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: MICRO 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 synthases. Prerequisite: MICRO 605, BIOCH 623 and MTHSC 206 or permission of instructor.

Biochemistry

| J.K. Zimmerman, Program Coordinator, Department of Biological Sciences |
|-----------------|-----------------|
| **Major** | **Degrees** |
| Biochemistry | M.S., Ph.D. |

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 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.

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. Prerequisite: BIOCH 423/623 or 431/631 or permission of instructor.

BIOCH 633: General Biochemistry Laboratory I, 1 cr. (0 and 4)
Experiments illustrate current methods used in biochemical research. Corequisite: BIOCH 423 or 431.

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; endocrinopathies 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, inhibition 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

| Thomas M. McInnis, Chair, Department of Biological Sciences |
|-----------------|-----------------|
| **Advanced degrees are not awarded in biological sciences as a major. These courses are taught by faculty in the Department of Biological Sciences to supplement courses and graduate degrees awarded in biochemistry, botany, genetics and zoology.** |

BIOSC 601: Plant Physiology, 3 cr. (3 and 0)
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 BIOSC 205 and CH 102 or 112. Corequisite: BIOSC 402/602.

BIOSC 602: Plant Physiology Laboratory, 1 cr. (0 and 3)
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 401/601.

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BIOSC 603: Protozoology, 3 cr.  
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.

BIOSC 604: Protozoology Laboratory, 2 cr. (1 and 2)  
Laboratory exercises reinforce the material presented in BIOSC 403 and introduce techniques used in collection, preservation and examination of protozoans. Corequisite: BIOSC 403/603.

BIOSC 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.

BIOSC 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 BIOSC 205. Corequisite: BIOSC 407/607.

BIOSC 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: BIOSC 406/606.

BIOSC 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: BIOSC 409/609.

BIOSC 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: BIOSC 408/608.

BIOSC 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.

BIOSC 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 rationale and methods for quantitative analyses of biota, as well as some integrated analyses of whole ecosystems. Prerequisite or Corequisite: BIOSC 410/610 or 443/643.

BIOSC 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.

BIOSC 617: Marine Biology, 3 cr. (3 and 0)  
Organisms that live in the sea and their adaptations to the marine environment; characteristics of marine habitats, organisms and the ecosystems. Prerequisite: BIOL 104 or permission of instructor.

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. Prerequisites: BIOCH 210 or 301 and MICRO 305 or permission of instructor.

BIOSC 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 or permission of instructor.

BIOSC 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 BIOSC 205.

BIOSC 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: BIOSC 425/625.

BIOSC 630 (BE 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.

BIOSC 632: Animal Histology, 3 cr. (3 and 0)  
Structural and functional study of the basic tissues of animals and tissue makeup of organs. Emphasis is on light microscopy with selected tissue studied at the electron microscope level. Prerequisite: BIOCH 303 or permission of instructor. Corequisite: BIOSC 433/633.

BIOSC 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: BIOSC 432/632.

BIOSC 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. Prerequisites: BIOCH 210 or 301 or permission of instructor. Corequisite: BIOSC 450/650.

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

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

BIOSC 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.

BIOSC 645: Ecology Laboratory, 2 cr. (1 and 2)  
Modern and classical approaches to the study of ecological problems discussed in BIOSC 441 and laboratory and computer-based analyses of plant and animal populations and communities. Prerequisite or Corequisite: BIOSC 441/641.
BIOSC 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 446/646 or permission of instructor.

BIOSC 650: Developmental Biology Laboratory, 2 cr. (1 and 2)
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 440/640 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 452/652.

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 457/657.

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 456/656.

BIOSC 658 (BE 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. Prerequisites: 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 459/659.

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)
Focus on molecular and microscopic analysis of eukaryotic cells. Corequisite: BIOSC 461/661.

BIOSC 664: Mammalogy, 3 cr. (2 and 3)
Origin, evolution, distribution, structure and function of mammals with 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 470/670 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 475; introduction to computer-aided data acquisition and manipulation as well as computer simulations of physiological function. Prerequisite or Corequisite: BIOSC 475/675.

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.

BIOSC 801: Electron Microscopy of Biological Specimens, 3 cr. (1 and 1) 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 812: Seminar, 1 cr. (1 and 0) 
Review and presentation of current literature in biological sciences. May be repeated for a maximum of four credits. Prerequisite: Permission of instructor.

BIOSC 815: Developmental Genetics, 3 cr. (3 and 3) F 
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, homebox 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 systematics and phylogeny, 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.

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.

Botany 
<p>| Thomas M McInnis, Chair, Department of Biological Sciences |
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<table>
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<tr>
<th>Majors</th>
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<tr>
<td>Botany</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 that 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, mycology, physiology or zoology. 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; photoperiodism. 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 characters 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) F 
Examination of plant-animal interactions from an ecological and evolutionary perspective. Topics include 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.
The M.S. and Ph.D. degrees in genetics (plant, animal and microbial) are offered through an interdepartmental program. Basic and applied research emphasis areas include biochemical, biometrical, molecular and population genetics, as well as bioinformatics, breeding, cytogenetics and structural and functional genomics.

Applicants to the program must have a bachelor's or master's degree; chemistry through organic or biochemistry; physics; mathematics through calculus; and biology including introductory genetics. Students with more than 18 hours of deficiencies will be admitted as postbaccalaureate enrollees until eligibility 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/BIO/MICRO 616, MICRO 615, CS ENV 605, AVS 652, BIO/SC 665, GEN 812, BIO/SC 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.
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, mechanisms 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.
Microbes that inhabit the marine environment, their peculiar physiological traits and contributions to the ecology of oceans. Prerequisites: 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. Prerequisites: MICRO 305 and organic chemistry.

MICRO 610: Soil Microbiology, 3 cr.
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 Physiological, 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. Prerequisites: 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.
Nature, production and function of basic immune responses in animals; procedures and mechanisms of antigen-antibody and other immune reactions. Prerequisites: MICRO 305 and organic chemistry.

MICRO 615: Microbial Genetics, 4 cr.
Cytological basis of bacterial, fungal and viral genetics; molecular aspects; mutations; mechanisms of genetic transfers; epiphenomes and plasmids; and population change. Prerequisites: BIOCH 301, CH 224 and MICRO 305 or permission of instructor.

MICRO 616: Introductory Virology, 3 cr.
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.
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 (Bios 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 blotting, bacterial and animal cell culture techniques, plasmids; cloning, Southern and Northern blotting; emphasis on practical experience. Prerequisites: BIOCH 210 or 301, MICRO 305 or permission of instructor.

MICRO 619: Molecular Medicine, 3 cr.
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 802: 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 803: Special Problems in Microbiology, credit to be arranged, F, S, SS
Research not related to a thesis.

MICRO 804: 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 805: Techniques of Clinical Microbiology and Immunobiology, 3 cr.
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 806: 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 807: 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 808: Biotechnology and Medicine, 3 cr. (3 and 0)
Medical problems currently receiving attention due to the development 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 809 (HLTH 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.

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: MICRO 305/605; BIOCH 423/623; MTHSC 206; or permission of instructor.

MICRO 812: 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.

MICRO 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 lyogenic bacteriophages. Prerequisite: BIOCH 415/615.

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

MICRO 991: Doctoral Dissertation Research, credit to be arranged

Zoology

James M. Colacino, Program Coordinator, Department of Biological Sciences

Major Degrees
Zoology M.S., Ph.D.

Students seeking the master's degree may select either a thesis or nonthesis option. Requirements for the thesis option include 24 semester hours of course work, six hours of research, an acceptable thesis and satisfactory performance in a final oral examination. Requirements for the nonthesis option include 36 semester hours of course work and satisfactory performance in a final comprehensive examination.

Requirements for the Ph.D. degree include written and oral comprehensive examinations, research, a dissertation and satisfactory performance in a final oral defense. Although there is no required course work for the doctorate beyond 18 semester hours of research, breadth and depth of preparation in the life sciences are expected of each candidate.

Zool 803: Population Dynamics, 4 cr.
(2 and 6) N
Fundamental mechanisms basic to regulation of natural animal populations. Laboratory research project in population dynamics complements theory.

Zool 810: Behavioral Ecology, 3 cr.
(3 and 0) N
Behavior of animals and the ecological context in which various behaviors are shown; empirical and theoretical aspects of behavioral ecology at individual, population and community levels. Prerequisites: BIOSC 441/641 and 470/670 or permission of instructor.

Zool 812: Seminar, 1 cr.
(1 and 0) N
Review of current literature in zoology.

Zool 815: Physiological Ecology, 4 cr.
(3 and 3) N
Physiological and biochemical adaptations of invertebrates and vertebrates toward various natural environmental parameters. Field trips acquaint students with natural macro- and micro-environments of individual species. Field measurements of parameters of the environment are undertaken, and laboratory studies furnish detailed knowledge of various physiological adaptations to these parameters.

Zool 816: Advanced Ecosystem Analysis, 4 cr.
(3 and 3) N
Description and analysis of ecological systems; biogeochemical, physicochemical and ecological principles emphasizing fundamental unity of ecosystems and their abiotic environment. Laboratory focuses on application of theory to actual field and laboratory research problems. Prerequisites: MTHSC 210 and 605; BIOSC 641 or BOT 846; or permission of instructor.

Zool 818: Community Ecology, 4 cr.
(3 and 3) N
Structure and function of ecological communities emphasizing description of natural communities and evolutionary rules by which they are organized. Laboratory applies theory to field problems. Prerequisites: MTHSC 108 and 605; BIOSC 641 or BOT 846; or permission of instructor.

Zool 835: Interpretive Electron Microscopy, 3 cr.
(3 and 0) N
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/BIOSC 801 or BIOSC 632 and 633 or permission of instructor.

Zool 863: Special Problems, 1-4 cr.
Research not related to thesis. Prerequisite: Permission of instructor.

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

Zool 991: Doctoral Dissertation Research, credit to be arranged

The Ph.D. and M.S. (thesis option) are research degrees that require a dissertation and thesis, respectively. The M.S. degree (thesis option) requires 24 credits of course work and six credits of research. The M.S. degree (nonthesis option), a terminal degree for students who do not plan research careers or do not plan to pursue a Ph.D. degree, requires 30 credits of course work. It may be suited for students who will pursue a career in business, educational or administrative areas that will not require research experience. The faculty participate in the plant health option of 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 genesis, morphology and classification.

CS ENV 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: CS ENV 202 or permission of instructor.

CS ENV 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 CS ENV 202.

CS ENV 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 biometrical methods. Prerequisite: GEN 302 or equivalent.
CS ENV 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. Prerequisites: AGRIC 104, CS ENV 202 or permission of instructor.

CS ENV 608 (EEAS 608) (BE 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 design 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.

CS ENV 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. Prerequisite: AGRIC 104 or equivalent introductory plant science, CS ENV 202.

CS ENV 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, CS ENV 202.

CS ENV 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, CS ENV 202 or permission of instructor.

CS ENV 624: Applied Aspects of Forage Management, 1 cr. (0 and 2) Hands-on exposure to forage plantings, establishment and management practices; pasture and harvested forage systems, equipment and practices; analysis of forage-livestock systems. Prerequisite or Corequisite: CS ENV 423/623.

CS ENV 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.

CS ENV 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.

CS ENV 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: CS ENV 407 or equivalent introductory weed science.

CS ENV 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: CS ENV 202.

CS ENV 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: CS ENV 202 or permission of instructor.

CS ENV 653: Soil Fertility Laboratory, 1 cr. (0 and 3) S
Evaluation and interpretation of soil fertility production. Prerequisite: CS ENV 202 or permission of instructor.

CS ENV 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: CS ENV 202, CH 101, 112, PHYS 207.

CS ENV 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 CS ENV 406 after consultation with instructor. Prerequisite: CS ENV 202, MICRO 305, PL PA 401, or permission of instructor.

CS ENV 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.

CS ENV 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.

CS ENV 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: CS ENV 403/603.

CS ENV 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: CS ENV 405/605 and EX ST 801 or permission of instructor.

CS ENV 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: CS ENV 452 or 403 or permission of instructor.

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

CS ENV 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.

CS ENV 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.

CS ENV 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: CS ENV 690 or MICRO 610 and permission of instructor.
CS ENV 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.

CS ENV 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.

CS ENV 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.

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

CS ENV 899: Doctoral Dissertation Research, credit to be arranged

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**Entomology**

| Josiah D. Culin, Chair, Department of Entomology |
|---|---|
| **Major** | **Degrees** |
| Entomology | M.S., Ph.D. |

The Department of Entomology is dedicated to providing leadership in environmental entomology. Research programs fall into four emphasis areas: aquatic arthropod diversity, crop-insect management, genetics and biotechnology, 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.

**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 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, 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 United 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 3)**
Concepts of insecticide toxicology; 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 toxicology 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. Prerequisite: 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.

**ENTOMOLOGY**

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 3)**
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 669 (W F B 669): Aquatic Insects, 3 cr. (1 and 6) S (odd numbered years)**
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.

**ENT 695 (GEN 695): Insect Biotechnology, 3 cr. (3 and 0)**
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.

**ENT 700: Entomology for Teachers, 3 cr. (2 and 2) S**
General entomology course for secondary school science teachers with emphasis on collecting and identifying the more common insects; 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.

**ENT 808: Taxonomy of Immature Insects, 3 cr. (1 and 6) F (odd numbered years)**
Identification of immature insects emphasizing the Holometabola. Identified collection required.

**ENT 809: Seminar in Entomology, 1 cr. (1 and 0)**
Current literature and research in entomology. Class attendance is mandatory. May be repeated for credit. Graded on a pass/fail basis.

**ENT 810: Selected Topics, 1-4 cr. (1-4 and 0)**
Current areas of entomological research and pest management. Course may be repeated for credit. Prerequisite: Permission of instructor.
ENT 843: Insect Pathology, 3 cr. (2 and 3) F (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. Prerequisite: ENT 301 or permission of the instructor.

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)
Entomological research not related to 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: ENT 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

### 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 800-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, S
Construction 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; designing samples for surveys in the social science fields. Prerequisite: EX ST 301.

EX ST 801: Statistical Methods I, 4 cr. (3 and 3) F, S, SS
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.

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 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.

EX ST 812: Selected Topics, 1-3 cr. (1-3 and 0) N
Topics in applied statistics not covered in other courses. May be repeated for different topics.

### Horticulture

Ted Whitwell, Chair, Department of Horticulture

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<th>Majors</th>
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<td>Horticulture</td>
<td>M.S.</td>
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<tr>
<td>Plant Physiology</td>
<td>Ph.D.</td>
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Research concentrations offered in molecular biology, plant breeding and genetics, tissue culture, weed science, photomorphogenesis, postharvest physiology, stress physiology, crop production, landscape design. 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. The Master of Science degree is offered in horticulture and genetics. Candidates are required to conduct original research leading to a thesis.

The department participates in interdepartmental programs awarding 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.

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 Web page: 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, 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, roadides 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 include plant identification, experiment and graphic representation. Prerequisites: BIOSC 205/206, HORT 101 and permission of instructor.

HORT 633 (CS ENV 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; problems involving methods of weed and herbicide injury diagnosis. Prerequisite: CS ENV 407 or equivalent introductory weed science.

HORT 635: Tree Fruit Culture and Physiology, 3 cr. (2 and 3) F (even numbered years)
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 652: Small Fruit Crops, 3 cr. (2 and 3) F (even numbered years)
Tannomax, 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 655: 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) S
Fundamental plant processes at both the cellular and molecular levels including genome structure and organization (both nuclear and organelar); regulation of gene expression in 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)
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: Horticulture: Plant and Environmental Science, 3 cr. (2 and 3) S
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 credit; total credit may not exceed four hours. 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 value, use, regional adaptation, establishment, 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, roadides and golf courses. Prerequisites: HORT 223 and 227, or CH 201 and PHYS 207, or BIOC 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, 2-4 cr. (1 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) F
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) 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.
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 plant diseases; causal factors, diagnosis and control strategies of noninfectious diseases of ornamental plants. Prerequisites: PL PA 401 or equivalent.

PL PA 606 (ENT 606): Diseases and Insects of Turfgrasses, 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. Prerequisites: ENT 301 and PL PA 401 or equivalents.

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 diseases; 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: MICRO 305, PL PA 401 or permission of instructor.

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: PL PA 401, 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: BIO SCI 104 or equivalent, PL PA 401 and BIO SCI 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: BIO SCI 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. Prerequisites: PL PA 411/611 or equivalent, and permission of instructor.

PL PA 807: Seminar, 1 cr. (1 and 0) F, S
Areas 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 (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)
Plant viruses their morphology, biochemistry, purification and transmission; 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 891: Master's Thesis Research, credit to be arranged

PL PA 991: Doctoral Dissertation Research, credit to be arranged

**Plant Physiology**

N. Dwight Camper, Program Coordinator, Department of Plant Pathology and Physiology

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<th>Major</th>
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<td>Plant Physiology</td>
<td>Ph.D.</td>
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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, 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:

**CS ENV 690: Beneficial Soil Organisms in Plant Growth, 3 cr. (3 and 0) F**

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 CS ENV 406 after consultation with instructor. **Prerequisites:** CS ENV 202, MICRO 305, PL PA 401 or permission of instructor.

**CS ENV 801: Crop Physiology and Nutrition, 3 cr. (3 and 0) F**

Basic concepts and physiologic aspects of growth and culture applied to crop management practices. **Prerequisites:** BIOSC 401/601 and 402/602 or equivalent.

**CS ENV 812: Crop Ecology and Land Use, 3 cr. (3 and 0) F**

Concepts and factors affecting adaptation and distribution of crop plants; micrometeorology and response to environmental factors modifications of microclimates by agricultural operations; interactions among crops and weeds and crop plants under field conditions.

**CS ENV 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, and 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 BIOC 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:** BIOC 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. **Prerequisites:** BIOC 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; dynamics of cellular growth and development in plants. **Prerequisites:** BIOC 401/601 and 402/602 or permission of instructor.

**BOT 891 (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:** BIOC 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:** BIOC 401/601 and 402/602 or permission of instructor.

**FOR 825: Wood Chemistry, 3 cr. (2 and 3) (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 991: Doctoral Dissertation Research, credit to be arranged**

**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 BIOC 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:** BIOC 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:** BIOC 401/601 and 402/602 or permission of instructor; BOT 823 preferred.
HORT 814: Environmental Plant Stress Physiology, 3 cr. (2 and 2)
Environmemal 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: BIOSCI 401/601 and 402/602 or permission of instructor.

HORT 991: Doctoral Dissertation Research, credit to be arranged

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. Prerequisite: BIOSCI 401/601 and 402/602 or PL PA 401 or permission of instructor.

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 hosts 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 Wildlife M.S., Ph.D.

Those who are interested in pursuing a graduate degree in aquaculture, fisheries or wildlife should have sound undergraduate training in the biological 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 the acceptance of the Graduate School and the Graduate Student Admission Committee of AFW. The Graduate Student Admission Committee of AFW will base their acceptance recommendations on 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 is usually preferred, but is 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.

Regulations for masters, fisheries and wildlife include 24 semester hours of course work, six hours of research credits (W F B 891), an acceptable thesis based on original research and satisfactory performance on a final oral examination. Additional course work usually includes subjects such as experimental statistics, biochemistry 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, a minimum of one semester of professional 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, wetland 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 Marine Center. The department also is associated with the National Council for Air and Stream Improvement and the Eastern Wildlife Program. The graduate program in wildlife biology is accredited by the Southeastern Section of the Wildlife Society.

W F B 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.

W F B 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 W F B 412.

W F B 616: Fishery Biology, 3 cr. (2 and 3)
Principles underlying freshwater fish production, major groups of freshwater fishes and their habitats, identification, age and growth, fecundity, food habits, population estimation, environmental evaluation, management practices and fish culture. Prerequisites: One year of introductory biology and junior standing.

W F B 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: W F B 350 or permission of the instructor.

W F B 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. Prerequisites: One year of general biology and junior standing.

W F B 660: Warmwater Fish Diseases, 2 cr. (2 and 0) SS (even numbered years)
Diseases in warmwater fish including infectious and noninfectious processes. Prerequisites: 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 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.
WF B 669 (ENT 669): Aquatic Insects, 3 cr. (1 and 6) S (odd numbered years)
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.

WF B 712: Wildlife Conservation for Teachers, 2-3 cr. (2-3 and O)
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.

WF 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.

WF 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.

WF B 810: Publishing in Natural Resource Journals, 2 cr. (2 and 0) S (odd numbered years)
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.

WF 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.

WF 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.

WF 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.

WF 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.

WF B 818: Waterfowl Ecology and Management, 3 cr. (2 and 3) F (odd numbered years)
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.

WF B 820: Seminar in Avian Ecology, 1 cr. (1 and 0) H
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.

WF B 830: Estimation of Animal Population Parameters, 3 cr. (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.

WF 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.

WF 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.

WF 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.

WF 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.

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

WF B 991: Doctoral Dissertation Research, credit to be arranged

Environmental Toxicology

John Rodgers, Chair, Department of Environmental Toxicology

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<tr>
<td>Environmental Toxicology</td>
<td>M.S., Ph.D.</td>
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Environmental toxicology is the scientific study of chemical, physical and biological stimuli in environments and the effects of these stimuli on living systems and their external and internal physical, chemical and biological integrity. Emphasizes include the metabolism of contaminants, their decomposition, fate and effects in aquatic and terrestrial environments. This interdisciplinary program provides a strong background in fundamental environmental toxicology and ecotoxicology. The program is in the School of Natural Resources and collaborates with several other programs across the University. It is administered jointly by the College of Agriculture, Forestry and Life Sciences and 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, environmental chemistry, biochemical and mechanistic 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 toxicants illustrate the mechanisms that govern chemical fate. Prerequisites: 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, 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. 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 also evaluated 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; 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 822: Analytical Toxicology Laboratory, 3 cr. (1 and 6)
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 toxicants 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; biochemical 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 830; 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 (algae, 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 increased 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

Forest Resources

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<th>Major</th>
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<tr>
<td>Forest Resources</td>
<td>M.F.R., M.S., Ph.D.</td>
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Enrollment in the Master of Forest Resources and Master of Science programs is open to students who have earned a baccalaureate degree in forestry, forest products or a related field. A master's degree, preferably in a forestry discipline, is required for enrollment in the Doctor of Philosophy program. The candidate may be required to satisfy undergraduate deficiencies before being admitted to full status.

The Master of Forest Resources, a nonthesis degree, requires a minimum of 36 semester hours of graduate course work with at least 18 of the required hours coming from courses numbered 700 or above.

A formal thesis is required for the Master of Science and the Doctor of Philosophy degrees. The Master of Science degree requires a minimum of 24 semester hours of course work and six hours of research. The Doctor of Philosophy degree requires a minimum of 16 semester hours of course work and 18 hours of research. For both degrees, one-half of the semester hours must be courses numbered 800 and above.

FOR 604: Forest Economics, 3 cr. (3 and 0) F
Economic problems and principles involved in the utilization of forest resources and distribution of forest products; analysis of integrated forest operations. Prerequisite: ECON 200 or permission of instructor.

FOR 607: Forest Operations, 3 cr. (2 and 3) F
Theory and practice of conducting forestry 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 permission 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: Senior standing or permission of instructor.

FOR 611: 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 612: 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)
Fundamental principles and analytical techniques in planning, management and optimization of forest operations. Prerequisites: FOR 302, 304, 308, 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 management principles and utilization of the hardwood forests of the Eastern 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: Senior standing 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 forestry 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 forest environments; 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.

FOR 641: Properties of Wood Products, 3 cr. (3 and 0)
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)
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)
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)
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)
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)
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 (EEES 651) (B 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, permission 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 permission 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. Prerequisite: 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 principles 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 1)  
Observation and measurement of species composition, community structure, soil-site relationships, land use practices within the forest ecosystems of Great Smoky 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

Gary J. Wells, Chair, Department of 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 nonthesis 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 and marketing, an introduction to economic principles. Prerequisite: AP EC 308 or 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 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 commodities futures contracts, with respect to the standpoint of the agribusiness entrepreneur. Prerequisite: AP EC 202 or ECON 211.

AP EC 611 (CRD 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 (CRD 612): Spatial Competition and Rural Development, 3 cr. (3 and 0) S
Development of an 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 Agriculture Trade, 3 cr. (3 and 0) S
Practical considerations of international 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 306 or permission of instructor.

AP EC 626 (CS ENV 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 agricultural crops. A major part of the course is a case study 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 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 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) S
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 competitiveness 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 679: 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) F
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) F
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) F
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) (MA SC 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) (MA SC 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 826 (ECON 826): 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 issues regulatory 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: C R D 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 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 critics, 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) S
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.

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.

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 technician. 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, actuation, 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, adjustment 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. Prerequisite: 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.
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. See the College of Engineering and Science for information on this program.

### BioSystems Engineering

**John C. Hayes, Chair, Department of Agricultural and Biological Engineering**

<table>
<thead>
<tr>
<th>Major</th>
<th>Degree</th>
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<tbody>
<tr>
<td>BioSystems Engineering</td>
<td>M.Eng., M.S., Ph.D.</td>
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</table>

Degree programs fall under one of the above areas with a concentration being offered in food science. 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 of ingredients in food on the qualities 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. **Prerequisites:** 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 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, microbiologically 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 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.

### Food Science and Human Nutrition

**John U. McGregor, Chair, Department of Food Science and Human Nutrition**

<table>
<thead>
<tr>
<th>Majors</th>
<th>Degrees</th>
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<tbody>
<tr>
<td>Animal and Food Industries</td>
<td>M.S.</td>
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<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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</table>

**Majors Degrees**

**Biochemistry and Human Nutrition**

- **BIOCH 210:** Food Chemistry I
- **BIOCH 211:** Food Chemistry II
- **BIOCH 301:** Biochemical Aspects of Poultry Products
- **BIOCH 302:** Chemical and Biochemical Aspects of Foods
- **BIOCH 310:** Physical and Thermophysical Properties of Foods
- **BIOCH 355:** Microbiology of Food Preservation and Processing
- **BIOCH 401:** Food Science Seminar
- **BIOCH 402:** Food Science Seminar
- **BIOCH 403:** Food Science Seminar

### Food Technology

**Ronald L. Thomas, Program Chairman, Department of Food Science**

<table>
<thead>
<tr>
<th>Major</th>
<th>Degree</th>
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<tbody>
<tr>
<td>Food Technology</td>
<td>Ph.D.</td>
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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

<table>
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<tr>
<th>Packaging Science</th>
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<tr>
<td>Robert F. Testin, Chair, Department of Packaging Science</td>
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<tr>
<td>Major</td>
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<tr>
<td>Packaging Science</td>
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</table>

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 Laboratory (PKGSC 664), 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: PKGSC 204, PHYS 207 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, TAPPI) of determining these properties; evaluation of functional properties of packages including shock and vibration isolation. Prerequisite: PHYS 207, PKGSC 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, PKGSC 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: PKGSC 404 or permission of instructor.

PKGSC 664 (FD SC 664): Food Packaging Systems, 3 cr. (3 and 0)
Characteristics and application of various materials 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.

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 materials, 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 Problems, 1-4 cr. (0 and 1-12)
Independent 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 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 non-parametric 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 801: 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 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 610: 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 611: 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 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, curing reactions, polymer solubility, influence of polymerization and processing conditions on polymer crystallinity. Prerequisites: CH E 210, 212, 214 or 411 and CH 224 and 332 or permission of instructor.

FD SC 615: Colloidal and Surface Science, 3 cr. (3 and 0)
Theory and application of colloidal and surface chemistry to ceramic materials and processes.

FD SC 623: International Business Management, 3 cr. (3 and 0)
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.

FD SC 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

**School of Design and Building • 78**
- Architecture • 78
- City and Regional Planning • 80
- Construction Science and Management • 82

**School of the Arts • 83**
- Fine Arts in Computing • 83
- Performing Arts • 83
- Visual Arts • 83

**School of Humanities • 85**
- English • 85
- History • 88
- Languages • 89
- Philosophy and Religion • 90
- Professional Communication • 90
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 the 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 Fulbright Senior Lectureships and Research Awards in many countries.

SCHOOL OF DESIGN AND BUILDING

Architecture

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<th>Jose R. Caban, Chair, School of Architecture</th>
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<tr>
<td>Major Degrees</td>
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<tr>
<td>Architecture M.Arch., M.S.</td>
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</table>

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 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 duration of study required for the Master of Architecture degree is normally two academic years, and degree candidates may elect a concentration of study in either architecture, or architecture and health care. The specific study plan of each student is determined in consultation with the major adviser and is intended to reflect individual educational objectives and career goals, while assuring a comprehensive development of professional competency. Requirements for the Master of Architecture degree include 45 credits of approved course work with a minimum grade point average of 3.00, along with acceptance of a thesis of 15 hours. All candidates for graduation are required to have 1,000 hours of practical experience in an architect's office.

The Master of Science degree in architecture is a postprofessional degree program which offers the opportunity to achieve advanced learning within the discipline of architecture, and to undertake research responsive to increasingly complex challenges attendant to the built environment. This is accomplished through a foundation of course work, accompanied by directed studies within a selected area of inquiry, and followed by the critical examination of a singular aspect of architecture in a research thesis.

Admission to the Master of Science degree program is available to students who have a first professional degree in architecture, and who possess the intellectual mettle and dedication of purpose necessary to respond successfully to the rigor of advanced study and independent research. This is measured by academic proficiency in prior work, a well-reasoned plan of advanced study and GRE general test scores. A personal interview is required of all applicants whose application material has been reviewed favorably by the Admissions Committee. More information concerning application procedures and requirements may be obtained by contacting 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 facilities, environmental issues in architecture, architecture and human perception, or theory and philosophy of architecture. A study plan is determined in consultation with the major adviser 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 adviser.

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.
Architecture 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 build 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 603: The Modern Architecture Movement, 3 cr. (3 and 0)
Seminar in 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 firsthand 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 applications 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 pre-modern and modern viewpoints to study its nonneutral role in shaping and reflecting knowledge, beliefs and actions within a cultural context.

ARCH 631: Virtual Reality in Architecture, 3 cr. (3 and 0)
Theories and concepts of virtual reality and their use in modeling three-dimensional spaces; computer modeling, lighting and texture mapping. Projects will focus on the creation and presentation of virtual environments. Prerequisite: Junior standing or permission of instructor.

ARCH 640: New York Field Study, 3 cr. (3 and 0)
Architecture, art, planning and urban design of New York featuring two-weeks' residence 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 501: 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, Ungers, 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 adviser.

* Offered only at the Daniel Center in Genoa, Italy.
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.

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. (0 and 9-27)
Complex architectural project emphasizing design exploration and independent work. Graded on a pass/fail basis. Prerequisites: ARCH 857 and 858.

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 planning 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.
   c. The final oral examination requires satisfactory answers to questions concerning the student’s thesis and concentration area.

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. (0 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 634: Geographic Information Systems for Landscape Planning, 3 cr. (1 and 6) S
Geographic information systems (GIS) technology and its application to various spatial analysis problems in landscape planning; data, development and management, spatial analysis techniques, critical review of GIS applications, needs analysis and institutional context, GIS hardware and software, hands-on application project.

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 tech-
C R P 674: Real Estate "Master Builder" Development Process, 3 cr. (3 and 0) S
Real estate and land development process 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 practitioners. Prerequisite: Permission of instructor or department chair.

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 emphasizes participants of 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 use-specific site analysis and generation of development alternatives. Prerequisite: C R P 831.

C R P 834: Planning Applications of Geographic Information Systems, 3 cr. (1 and 6) S
Further studies in spatial data development and analysis skills in applied, real-world context. Students first gain competence in professional level GIS software. Competence is solidified through completion of real-world GIS application, followed by completion of individual applications projects, exploration of specialized, advanced software capabilities. Prerequisites: C R P 434/634 or permission of instructor.

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 development of individual 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 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 climate change; students pursue individual GIS field and student interests. Prerequisite: Graduate standing.

C R P 844 (PRMT 844): Outdoor Recreation Resource Management and Planning, 3 cr. (3 and 0) S
Issues relating to planning and development of natural areas for recreational purposes. Emphasis 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 9) 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 and simulation; 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 adviser, 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 substituted for C R P 854, 863 or 865 with approval of credit hours by major adviser.

C R P 863: Urban and Metropolitan Planning Studies: Studio, 3-6 cr. (0 and 9-18) N
Projects pertaining to land use, transportation, urban design, public facilities, public services, capital improvement program, etc., accomplished through individual or small group activity under guidance of planning faculty.

C R P 866: Comprehensive Planning Studio, 6 cr. (3 and 9) F
Serves as a vehicle for synthesis and application of skills developed in other courses, allowing students to pursue in one or more real-world planning projects in addition to seminars and readings devoted to development of professional practice skills. Prerequisite: Second year C R P student or permission of instructor.

C R P 868: Special Area Management Planning, 3 cr. (3 and 0) F
Issues relating to the development, implementation and evaluation of plans and programs to manage the natural resources of designated areas. Emphasis is on the policy-making process at the federal, state, regional and local levels.

C R P 871: Growth Management and Legal Issues, 3 cr. (3 and 0) S
Basic laws and court cases relating to the comprehensive plan, implementing tools and other aspects of the planning process in the growth management context. Prerequisites: C R P 672 and permission of instructor or department chair.
C R P 872: Housing Issues in the United States, 3 cr. (3 and 0) F
Regulation, stimulation, salvage and replacement of housing through public policy administrative procedures, specific housing programs analyzed in detail.

C R P 873: Economic Development Planning, 3 cr. (3 and 0) F
Economic development planning process, focusing on applied programmatic techniques, especially at the state, local and neighborhood levels. Emphasis is on theoretical models, economic development planning process, private/public partnerships, economic development tools, political context, and economic development planning administration and organization. Prerequisites: C R P 872 and 853 or permission of instructor.

C R P 881: Quantitative Methods for Urban Planning and Policy, 3 cr. (3 and 0) F
Use of quantitative information for policy analysis in planning and related fields; topics covered include measurement in planning, regression, and computer use in planning and related professions. Prerequisite: Permission of instructor or department chair.

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 or graduate faculty. May be repeated for credit.

C R P 891: Planning Thesis, 1-9 cr. (0 and 1-9) F, S
Student, working 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.

C R P 894: Planning Internship Seminar, 3 cr. (3 and 0)
Seminar-based analysis of student internships, enabling students to compare experiences and gain greater understanding of professional practice by reflecting on planning issues. Graded on a pass/fail basis. Prerequisite: C R P 893.

Construction Science and Management
Roger Liska, Chair, Department of Construction Science and Management

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<th>Major</th>
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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 entering 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) and C S M 852. 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 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 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 granted as part of the department's core. Approval must be received from the student's adviser 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: Construction Science and Management or Design major, senior standing or permission of department chair.

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 6)
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 6)
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 C S M graduate program. Graded on a credit/no credit basis; a letter grade is not given; will not count toward a graduate degree.

THEA 672: Improvisation: Interpreting and Developing Texts, 3 cr. (3 and 0)
Provides practical applications using drama as a learning tool to strengthen writing skills, motivate collaboration and heighten analytical skills. Students will use improvisation to analyze texts and to revise original work, consider theory and research of contemporary scholars, and develop approaches to literature and composition based on readings and drama experiences. Prerequisite: Senior standing or permission of instructor.

THEA 687: Stage Lighting, 3 cr. (2 and 2)
Theory and practice of stage lighting through an understanding of various lighting instruments, lighting control systems and execution of lighting designs.
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 document 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 additional advanced work. Directed studies must be arranged with a specific instructor prior to registration. May be repeated for a maximum of 18 credits. Prerequisite: Permission of instructor.

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 880: Visual Arts Studio, 3-15 cr. (0 and 6-30)
Continuation of ART 870. May be repeated for a 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 a maximum of 15 credits. Prerequisite: Permission of department chair or instructor.

ART 891: Master's Thesis Research, 3-15 cr. (0 and 6-30)
Continuation of ART 871. May be repeated for a maximum of 15 credits. Prerequisite: Permission of department chair or instructor.

ART 891: Master's Thesis Research, 3-15 cr. (0 and 6-30)
Continuation of ART 871. May be repeated for a maximum of 15 credits. Prerequisite: Permission of department chair or instructor.

No degrees are offered in art and architectural history. Courses are offered to provide electives for students in other areas.

A H 611: Directed Research in Art History I, 3 cr. (3 and 0)
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 H 612: Directed Research in Art History II, 3 cr. (3 and 0)
Continuation of A H 611.

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 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

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<td>English</td>
<td>M.A.</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 600 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 685 (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 in 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 in English 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 readings in English 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 from 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 century.  
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 of the Irish tradition: 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 640: Literary Theory, 3 cr. (3 and 0)  
How approaches such as Marxism, psychoanalysis, Feminism, Deconstruction, New Historicism, Post-Colonialism, Cultural Studies and Queer Theory answer the question 'What is Literature?'  
Prerequisite: Sophomore literature.

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 Arts of 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 678: Digital Literacy, 3 cr.  
(3 and 0)  
Examines how electronic texts differ from and resemble print texts. Includes reading, studying and analyzing print and digital texts to determine how digital techniques change patterns of reading and how readers make sense of electronic texts. Prerequisite: ENGL 304 or permission of instructor.

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 course 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 838: Digital Publishing Technologies: Theories in Practice, 3 cr.  
(3 and 0)  
User-centered design theories applied to multimedia interfaces and on-line 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)  
Independent/Directed study. 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 or technical journalism, 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 855: 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)
Prerequisite: ENGL 853.

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 adviser(s). Credit to be arranged. A maximum of three credits may be counted toward the degree.

SPCH 656: Crisis Communication, 3 cr. (3 and 0)
The use of communication in planning, managing and responding to organizational crisis. 
Prerequisite: Senior standing, graduate standing or permission of instructor.

SPCH 664: Advanced Organizational Communication, 3 cr. (3 and 0)
Application of speech communication methodology to the analysis of organizational communication processes; methods of organizational communication analysis and intervention. 
Prerequisite: SPCH 364 or permission of instructor.

SPCH 670: Communication and Health, 3 cr. (3 and 0)
Institutional and health care communication issues; the relationship between social issues, communication and health.

WS 659: Selected Topics in Women's Studies, 1-3 cr. (1-3 and 0)
Selected topics in women's studies 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 628: Trial in US History, 3 cr. (3 and 0)
Social, cultural and legal context of a famous American trial, with consideration given to the actual trial record (transcripts, briefs and opinions on appeal) and to historical studies of the time and place in which the trial arose. Trial selected will vary as course is taught. 
Prerequisites: HIST 328 or 329 or permission of instructor (for undergraduates).

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 651: Alexander the Great, 3 cr. (3 and 0)
The career of Alexander the Great and the history and archaeology of ancient Macedonia.

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 countries, 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 715: 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 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 872: Issues and Methods in European and Non-Western History, 3 cr. (3 and 0)
Seminar discussion of contemporary approaches to European and non-Western history; exploration of theoretical and empirical debates.

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 the 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 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. Prerequisites: 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.

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**Languages**

Samuel C. King, Chair, Department of Languages

Advanced degrees are not awarded in languages. Courses are offered to provide electives for students in other areas.

**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: Special Topics, 3 cr. (3 and 0)
Study of timely or special topics in Spanish. May be repeated for a total of six credits if different topics are covered. Prerequisite: SPAN 303, 311, 404 or 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 for credit. 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 for credit. Prerequisite: Graduate standing.

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 program 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 a variety of academic uses and can produce high-quality documents that meet the needs of technical communicators in industry and academic settings.

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 Technical Communication (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 (HRD 847), Instructional Video Production (HRD 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 with written documentation of 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 GPA 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.
College of Business and Public Affairs

School of Accountancy and Legal Studies • 92
Accounting • 92

School of Business and Leadership • 93
Applied Economics • 93
Business Administration • 93
Economics • 96
Finance • 98
Graphic Communications • 99
Industrial Management • 100
Management Science • 102
Marketing • 104

School of Social Science and Applied Sociology • 104
Political Science • 104
Psychology • 106
Sociology • 108
The mission of the College of Business and Public Affairs is to: develop leaders who are exceptionally qualified, globally competitive, entrepreneurial and committed to the betterment of society; produce scholarly research that is relevant to our stakeholders; and support professional and public service activities that contribute to economic, social and intellectual development.

The College of Business and Public Affairs offers advanced degrees in these areas of study:

- Accounting
- Applied Economics*
- Business Administration
- Economics
- Graphic Communications
- 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.

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SCHOOL OF ACCOUNTANCY AND LEGAL STUDIES

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<th>Accounting</th>
<th>M.P.Acc.</th>
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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. Full-time students are able to complete the program in one calendar year. 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)
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 control 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 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)
Principles and concepts involved in partnership taxation, 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 implications for management decision making. Prerequisite: ACCT 830 or equivalent.

ACCT 845: Operational Auditing Seminar, 3 cr. (3 and 0)
Management control and operational systems, opportunities for improvement and development 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.

ACCT 899: Professional Exam Review, 0 cr. (0 and 0)
Preparation for professional examination of the student's choice, either the Certified Public Accountant, Certified Management Accountant or Certified Internal Auditor exam. Graded on a credit/no credit basis; a letter grade is not given; must be completed prior to receiving MPAcc degree; does not contribute hours toward degree completion. Prerequisite: None.

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 responsibility 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; 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)
Timely topics in legal studies. May be repeated for a maximum of six credits, but only if different topics are covered. Prerequisites: Senior standing and permission of instructor.

LAW 801: Law for Professional Accountants, 3 cr. (3 and 0)
Preparation for professional exams and responsibilities in managerial positions; topics include professional and legal responsibilities of accountants, business organizations, commercial law, government regulation of business, and property. Case studies, problems and student papers will be utilized. Prerequisite: Law 322 or equivalent.

SCHOOL OF BUSINESS AND LEADERSHIP

Applied Economics

| Gary J. Wells, Chair, Department of Agricultural and Applied Economics |
|---------------------------|----------------|
| Major                     | Degree       |
| Applied Economics         | Ph.D.        |

See the College of Agriculture, Forestry and Life Sciences for information on this program.

Business Administration

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<th>Martha Duke, Associate Director*</th>
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The Master of Business Administration degree program is designed for the study of advanced concepts of 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 Landers 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; a basic computer science or computer applications course. 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)
Provides breadth and depth in the application of statistical techniques building on basic statistical knowledge gained in M B A 818. Topics include the analysis of variance, simple and multiple regression analysis, forecasting and Non-parametric Statistics. Prerequisite: 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 guidance and control of a business enterprise. Case material and problems are used. Prerequisites: M B A 819 or equivalent or permission of instructor.

M B A 805: Enterprise, Government and the Public, 3 cr. (3 and 0)
N The regulatory environment of business and how it evolves. Through use of economic logic and business cases, students are equipped to understand the all-pervading nature and importance of government regulation in the economy. Prerequisite: Graduate standing.

M B A 806: Operations Management, 3 cr. (3 and 0)
How firms create value and how decisions in the areas of capacity, facilities, technology, vertical integration, workforce, quality, production planning/materials control and organization influence a firm's ability to add value; decisions and analysis tools used for these decisions. Prerequisites: M B A 818 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 decisions 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) 250-8898. Correspondence for the program at the Clemson campus and for classes at Lander University should be addressed to Clemson M.B.A. Program, 124 Sumter Hall, Clemson, S.C. 29634; or call (864) 656-3973. Information on classes at Lander University can be obtained by calling (864) 588-8787.

BUSINESS ADMINISTRATION

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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: MBA 829 or equivalent and MBA 803, 804 and 807; or permission of instructor.

MBA 809 (MGT 809): Organizational Behavior and Human Resources Management, 3 cr. (3 and 0)
Theories and models of behavior; 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 resource strategies, selection, performance evaluation, reward systems and employee development. 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. Prerequisites: MBA 806, 807, 808 and 809.

MBA 811: International Business Management, 3 cr. (3 and 0) N
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 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: MBA 807 or MBA 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

MBA 815: Directed Research in Qualitative Analysis, 3 cr. (3 and 0) N

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) N
Probability distributions, sampling distributions, confidence intervals, hypothesis testing, linear programming, sensitivity analysis and simulation. Both statistics and management science applications integrated into existing software packages such as Excel. Prerequisite: Permission of MBA director.

MBA 819: Introduction to Accounting and Finance, 3 cr. (3 and 0)
Basic concepts of accounting and finance with emphasis on using financial data for decision making; measuring, processing, reporting and analysis of financial information; use of discounted cash flow analysis in valuation and the measurement of risk and return. Designed for the MBA student lacking background in accounting and finance. Prerequisite: Permission of MBA director.

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 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: Business 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 service delivery. Prerequisite: MBA 808 or 858 or permission of instructor.

MBA 829: Marketing Foundations, 2 cr. (2 and 0)
Principles and concepts involved in the planning, pricing, promoting and distributing goods and services. Prerequisite: Permission of MBA director.

MBA 832 (FIN 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. Prerequisite: MBA 807 or MBA 857 or permission of instructor.
MBA 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.

MBA 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 and real estate investment risk analysis. Prerequisite: MBA A/FIN 807 or MBA A 857 or permission of instructor.

MBA 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. May not be used as credit toward a graduate degree. Prerequisite: Permission of MBA director.

MBA 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 MBA director.

MBA 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: MBA A 837, 838 or permission of instructor.

MBA 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.

MBA 846: Use of Derivatives in Financial Engineering, 3 cr. (3 and 0) N
The valuation and use of basic derivative securities such as futures and options; the financial engineering of securities combinations such as swaps, spreads and straddles; applications of derivatives and financial engineering in managing financial risks. Prerequisite: MBA A 807 or MBA A 867 or permission of instructor.

MBA 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 MBA director.

MBA 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 MBA director.

MBA 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; profit planning, budgeting and standards; product and segment costing and evaluation; case studies and computer-based assignments. Prerequisite: MBA 819 or equivalent or permission of instructor.

MBA 856: 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: MBA 853 or permission of instructor.

MBA 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 market-
MBA 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 multibusines firms. Business classes, case discussions and group projects used to integrate content from previous business courses. Prerequisites: M B A 807, 809, 838, 854, 856, 861 and 862; or permission of instructor.

M B A 871: Advanced System Development, 3 cr. (3 and 0) N
Development of information systems using modern client/server techniques and software tools. Specific techniques and tools covered will be updated to incorporate the newest technologies. Prerequisite: M B A/ M G T 861 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 876: Electronic Marketing, 3 cr. (3 and 0) N
Application of the concepts and theories of marketing to e-commerce; challenges facing marketing in business-to-business and business-to-consumer contexts; strategic application of marketing mix variables in e-business environment. Prerequisite: Permission of instructor.

M B A 888: Internship in Business Administration, 0 cr. (0 and 0) N
Preplanned, approved, 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: 24 semester hours of graduate credit and permission of 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.

Economics

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<tr>
<td>Applied Economics</td>
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Applicants to the M.A. degree program must have completed at least 12 semester hours of undergraduate economics, including a course in intermediate price theory. A background in mathematics, including at least one course each in calculus and statistics, also required. When necessary, the economic theory, mathematics and statistics courses may be taken at Clemson University.

The graduate program will include at least one course in econometrics and a minimum of two courses in economic theory. Program concentrations in financial economics, labor economics, monetary economics, environmental economics, industrial organization and public sector economics have been designed for students interested in these areas.

Both thesis and nonthesis options are available. The thesis option requires completion of 24 semester hours of course work and submission of an approved thesis. The nonthesis option requires completion of 30 semester hours of course work and a passing score on the M.A. qualifying examination. With the permission of the graduate coordinator, a maximum of six hours of course work credit may be earned for graduate courses taken outside the Department of Economics. All required courses must be selected from within the department.

Applicants to the Ph.D. program should have a strong background in economic theory and statistics. The program has required fields in these areas. Students choose two additional fields of concentration from those listed above and others supported by departments across the University.

ECON 605: Introduction to Econometrics, 4 cr. (3 and 3)
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 are introduced. Prerequisites: ECON 200 or 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 essential aspects of international economic linkages. Gains and redistributive effects of trade and the barriers to trade are discussed within the context of a variety of economic models. The history of trade policy and the political economy of its determination will also be discussed. Prerequisite: ECON 314 or permission of instructor.

ECON 750: Economic Concepts and Classroom Applications for Teachers
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 Economic Concepts and Applications, 3 cr. (3 and 0)
Rigorous development of price theory under alternative product and resource market structures. Prerequisite: Permission of instructor.

ECON 804 (AP EC 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.

ECON 805: Macroeconomic Theory, 3 cr. (3 and 0) S
Macroeconomic theory involving static and dynamic models and their use in analysis of economic problems and policies.
ECON 806 (AP EC 806): Econometrics I, 3 cr. (3 and 0) Application of econometric techniques and stochastic models to economic problems. Topics include distribution theory, simple and multiple regression modeling, hypothesis testing and other issues in regression analysis.

ECON 807 (MA SC 807) (AP EC 807): Econometrics II, 3 cr. (3 and 0) F Economic models expressed as systems of equations; problems of identification, parameter estimation, measurement errors and statistical inference; techniques of simulation, forecasting, model validation and interpretation.

ECON 808 (MA SC 808) (AP EC 808): Econometrics III, 3 cr. (3 and 0) S Continuation of ECON 807: current economic models and estimation procedures. Prerequisite: ECON 807.

ECON 809 (AP EC 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.

ECON 810 (AP EC 810): Natural Resources Management and Policy, 3 cr. (3 and 0) 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.

ECON 811 (AP EC 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.

ECON 816 (AP EC 816): Labor Economics, 3 cr. (3 and 0) Wage and unemployment theory; labor markets; labor history; current problems in labor and manpower economics.

ECON 817 (AP EC 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.

ECON 820 (AP EC 820): Public Finance, 3 cr. (3 and 0) F Impact of government on resource allocation, income distribution and stability; role of regulation; principles of taxation.

ECON 821 (AP EC 821): Public Choice, 3 cr. (3 and 0) Economic theory to analyze collective decisions. Topics include the pure theory of collective choice and applied analyses of democratic governments and their policy processes.

ECON 822 (AP EC 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.

ECON 824 (AP EC 824): Organization of Industry, 3 cr. (3 and 0) The structure of markets and firms; forces that determine the size of firms and the boundaries of markets; the behavior of firms, both singly and in concert, to exploit market positions.

ECON 826 (AP EC 826): Economic Theory of Government Regulation, 3 cr. (3 and 0) The scope of governmental regulation in the economy of the United States, its evolution and development; the application of the tools of economic analysis to the issues of regulated enterprise. Prerequisite: ECON 314 or equivalent.

ECON 827 (AP EC 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; the importance of property rights structures in the organization of business and in managerial decision making. Prerequisite: ECON 801.

ECON 828 (AP EC 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.

ECON 831 (AP EC 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.

ECON 832 (AP EC 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: CRD 612 or permission of instructor.

ECON 840 (AP EC 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.

ECON 841 (AP EC 841): International Finance, 3 cr. (3 and 0) Financial economics of decision making in a multinational environment featuring autonomous governments and multiple currencies. Typical topics include 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.

ECON 855 (AP EC 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.

ECON 888 (AP EC 888): Directed Reading 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.

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

ECON 899 (AP EC 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.

ECON 900: Selected Topics in Economics, 3 cr. (3 and 0) F (odd numbered years) Current topics in economic theory and empirical research. May be taken more than once for credit as long as subject matter is not repetitive.

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)
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 standing the comprehensive examination preliminary to admission to candidacy for 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) F
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) F
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

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**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.

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**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 option pricing theory 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 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 807 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 risks. **Prerequisite:** M B A 807 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/FIN 807 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. **Prerequisite:** M B A/FIN 807 or M B A 857 or permission of instructor.
The Master of Science in Graphic Communications degree program is designed to prepare students for technical, creative or professional careers in graphic communications, the third largest manufacturing industry in the United States. The M.S. in GC program serves the needs of graphic communications, graphic arts, printing management or graphic design graduates from other institutions, as well as undergraduates with degrees in engineering, manufacturing, computer sciences, communications, technology and various business fields wanting to transition to graphic communications fields.

The Clemson M.S. in GC is enhanced by Clemson's undergraduate program of over 400 students and works closely with Clemson's nationally recognized packaging sciences programs. Industry supports well-equipped GC laboratories. M.S. in GC are placed in positions in a variety of printing, packaging, publishing, imaging and related industries in management, marketing, sales, customer service, creative, technical, scientific and academic positions. Graduates' placement rates are consistently high.

Program entrance is available fall, spring and first or second summer terms. Requirements for the program include 33 semester hours of graduate courses for a nonthesis option, or 30 hours with a thesis. Within the total requirements, at least 17 hours will be in GC technical/managerial courses, seven will be research related, six credits must be from outside the GC department and at least one-half will be at or above the 800 level. Based upon applicant's undergraduate course work and work experience background, prerequisite courses may be required in specific areas. Students without relevant work experience will also complete an industrial internship.

In addition to the standard Application for Admission to the Clemson University Graduate School, the GC department admissions committee requests a narrative of approximately two pages in length, to include related and nonrelated work history, educational background, current position and an explanation of how Clemson's M.S. in GC program relates to the applicant's professional goals. A separate resume should accompany the narrative.

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 prepress; 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 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 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 the interrelationship among inks, substrates and the printing process. Through controlled testing and examination, the optimum conditions for improved printability will be determined. Prerequisites: G C 406 or 440 or permission of instructor.

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. Prerequisite: 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 and 450.

G C 690: Selected Topics, 1-3 cr. (1-3 and 0)
Subject areas not covered in other GC courses; organized according to industry trends and student trends. May be repeated, but only if different topics are covered. Prerequisite: Permission of instructor.

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 850: G C Internship, 1 cr. (1 and 0)
Full-time employment for hands-on experience in manufacturing, marketing or managing within the GC industry. For G C graduate students only. May be repeated for a total of two credits. Prerequisites: G C 310 or equivalent and permission of instructor.

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, packaging or allied industries. Prerequisites: G C 894, acceptance of a written proposal and approval of adviser.

G C 898: Graphic Communications Research Problems II, 3 cr. (3 and 0)
Performing in-depth investigation of phenomena relative to the printing, packaging or allied industries. Continuation of G C 897. Prerequisites: G C 894, 897, acceptance of a written proposal and approval of adviser.

Industrial Management

Terry L. Leap, Chair, Department of Management

<table>
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<th>Major</th>
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<td>Industrial Management</td>
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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 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 operations management. The program focuses on the capabilities and resources of operations, and the role of operations in the formulations and implementations of organization strategies. The program addresses critical material and information flows within the organization, providing a knowledge base and skill set for solving the problems of operations. Students select from an array of operations focus courses. The program requires five core courses and five operations focus courses. 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, operations, management science, human resource management and statistics must complete courses in these areas prior to taking core courses.

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, operations 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 three core courses, five scholarly methods courses and a minimum of six advanced courses. These 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 or strategic management. Finally, the student must complete at least 18 credit hours of doctoral dissertation research.

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 techniques as they apply to manufacturing individual and work-group behavior in organizations. Organizational behavior topics include leadership, motivation and teamwork. Human resource management topics include human resource strategy, selection, performance evaluation, reward systems and employee development. Prerequisite: Graduate standing.

MGT 812: Supply Chain Management, 3 cr. (3 and 0) SS
In-depth study, through case studies and readings, of methodologies for designing and managing integrated, international supply chain networks. Topics include supply network design; distribution strategy, strategic alliances, inventory management, coordinated product and network design and information systems for supply chain. Prerequisite: Permission of instructor.

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: E-Commerce Web Site Development, 3 cr. (2 and 1)
Enabling information technologies for electronic commerce, including databases and web applications. Includes applying these technologies to a project. Prerequisite: Permission of instructor.

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 opera-
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 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, transportation, configuration, and coordination of global operations activities. Prerequisite: MGT 803 or permission of instructor.

MGT 845 (M B A 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 (M B A 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 system analysis, object-oriented modeling and database design. Prerequisite: Basic computer skills.

MGT 874 (M B A 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: C E 635; CP SC 840, I E 803, MA SC 819; M B A 859; MTHSC 812 or 814 and permission of instructor.

MGT 886: International Perspectives in Industrial Management, 3-6 cr. (3-6 and 0)
International perspective to industrial management via organized plant visits 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 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 results (theoretical and empirical) dealing with alternative approaches for planning and control of manufacturing operations. Prerequisite: MGT 808 and 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: MGT 803 or 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 management issues and developments in the evaluation, selection, design and implementation 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 921 and permission of instructor.

MGT 910: Seminar in Operations Management, 1-3 cr. (1-3 and 0)
New methodological 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: CP SC 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 818 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)
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 |
|---|---|
| Major | Degree |
| Management Science | Ph.D. |

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.

MA SC 807 (ECON 807) (AP EC 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.

MA SC 808 (ECON 808) (AP EC 808): Econometrics III, 3 cr. (3 and 0) S
Continuation of ECON 807; current economic models and estimation procedures. Prerequisite: ECON 807.

MA SC 810: Foundations of Management Science, 3 cr. (3 and 0) S
Fundamental management science modeling techniques emphasizing problem formulation, computer solution and economic analysis in an operations context; queuing analysis, computer simulation and mathematical programming approaches including linear, goal and integer programming. Application areas encompass production, capacity and project planning, scheduling, location, layout and logistics. Prerequisite: Permission of instructor.

MA SC 812: Management Science II, 3 cr. (3 and 0) F
Continuation of MA SC 810; dynamic, integer and nonlinear programming emphasizing applications of different types of mathematical programming to business and industrial problems. Prerequisite: MA SC 810 or permission of instructor.

MA SC 814: Design of Experiments in Business and Management, 3 cr. (3 and 0) S
Design and analysis of experiments with a focus on business and industrial applications. Topics range from the analysis of single-factor experimental designs through factorial experiments, multiple comparisons and confounding. Problems arising in the actual industrial environments are used to illustrate the application of the techniques and to introduce the student to major statistical software packages for the analysis of experimental data.

**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)
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 829: Management of E-Commerce, 3 cr. (3 and 0)
Concepts of electronic commerce as facilitated by the Internet and related technologies. Topics include: the catalysts for e-commerce (both B2B and B2C), technological challenges, legal and regulatory framework, behavior and educational challenges, and strategies for e-commerce. Prerequisite: Permission of instructor.

MGT 833: E-Commerce Project, 3 cr. (0 and 9)
Application of e-commerce knowledge to a significant problem or opportunity. Prerequisites: Submission of a written proposal and prior approval of instructor.

MGT 861 (MBA 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

*Dr. Nelson is a faculty member in mathematical sciences.*
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 808 and 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; optimization systems, location and layout; and management systems selection and installation. **Prerequisite:** MGT 821 and permission of instructor.

**MGT 910:** Seminar in Operations Management, 1-3 cr. (1-3 and 0)
New methodological 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 913:** 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:** CPSC 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 informative expectation, functions of random variables, moment generating functions, distribution theory and limit theorems. **Prerequisite:** MTHSC 206.

**MTHSC 801:** General Linear Hypothesis, 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-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 of communication theory and operations research. **Prerequisite:** MTHSC 400/600 or 800.

**MTHSC 805:** Data Analysis, 3 cr. (3 and 1) F, S
Methodological 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 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 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 computer-oriented techniques: 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 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, queuing and shortest path. **Prerequisite:** MTHSC 803.
MKT 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.

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, MTHSC 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**

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<tr>
<td>David Swindell, Director of Public Administration Program</td>
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<tr>
<td>Major</td>
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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 39 to 45 semester hours are required for the M.P.A. degree, depending on the student’s background. Students lacking proficiency in American government are required to take a prerequisite in this area to address the deficiency. Students who do not have substantial administrative experience are required to complete an internship encompassing 480 hours in a public or nonprofit agency engaged in 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 860, 867 or 868) and five electives. Finally, all students must demonstrate a proficient knowledge of the field of public administration by passing a comprehensive examination. Students may request to take the Capstone Seminar in Public Administration (PO SC 880) in lieu of the comprehensive examination.

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: PO SC 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 660: 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: Research Methods for Public Administration, 3 cr. (3 and 0)
Use of social science research methods for addressing issues in public management and policy; research design; measurement; sampling and polling. Various aspects of locating, collecting, and processing data, including survey design and archive searches.

PO SC 821: Perspectives on Public Administration, 3 cr. (3 and 0)
Study and practice of public administration in the United States in the 20th 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 specializations, 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 database management, storage and retrieval. Data description. Univariate, bivariate and multivariate analysis in policy studies and decision-making theory. Prerequisite: 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)
Problems 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.

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<td>James McCubbin, Chair, Department of Psychology</td>
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<tr>
<td><strong>Majors</strong></td>
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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, skills 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 concentration is fully accredited by the Human Factors and Ergonomics Society.

GINT 767: State Government, Prerequisites: 30 credit hours toward MPA degree and permission of instructor.

GINT 771: Public Data Analysis, Prerequisites: 30 credit hours toward MPA degree and permission of instructor.

GINT 773: Personnel Administration, Prerequisites: 30 credit hours toward MPA degree and permission of instructor.

GINT 774: The Public Policy Process, Prerequisites: 30 credit hours toward MPA degree and 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. Prerequisites: 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. Prerequisites: Graduate standing and permission of instructor.

PSYCH 801: Professional Ethics in Industrial/Organizational Psychology, 2 cr. (2 and 0)
Ethics and standards for the practice of psychology in organizations; applied situations in organizational settings and in research. Prerequisite: Permission of instructor.

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 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. Prerequisites: 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 instructional methodologies such as fairness in training, special populations, second careers, hard-core unemployment, and ethics of organizational and industrial change. Prerequisite: A course in industrial psychology, personnel psychology or equivalent.

PSYCH 861: Personnel Psychology, 3 cr. (3 and 0)
Theory, techniques and legal issues involved in the effective matching of individuals' needs, preferences, skills and abilities with the needs and preferences of organizations. Topics include research methods, prediction issues, tests and other predictors, decision making and job evaluation. Prerequisite: PSYCH 810.

PSYCH 862: Organizational Development, 3 cr. (3 and 0)
Forms of organizational structure and basic theories of organizations; theories and technologies of organizational development and change; relationships between organizational design and technology. Prerequisite: A course in industrial/organizational psychology or equivalent.

PSYCH 863: Work Motivation and Satisfaction, 3 cr. (3 and 0)
Explanations for absenteeism, productivity, job satisfaction and withdrawal, as well as their interrelations; methods of measuring attitudes and opinions and general theories of human motivation. Prerequisite: An industrial/organizational psychology course or equivalent.

PSYCH 864: Performance Appraisal, 3 cr. (3 and 0)
Job measurement and the psychological processes involved in performance appraisal; 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 868: Leadership in Organizations, 3 cr. (3 and 0)
Theories of leadership and current leadership research; theoretical approaches include trait, behavioral, contingency, transactional and transformational approaches; current leadership issues may include leadership perceptions, gender and leadership, and executive succession. Prerequisite: An industrial/organizational psychology course or equivalent.

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; empirical and theoretical issues in the understanding of mental disorders; 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.
Sociology

John W. Ryan, Chair, Department of Sociology

Major Degree
Applied Sociology M.S.

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.

Students selecting the thesis option are required to complete a minimum of 34 hours of course work including SOC 803, 805, 807, 810, 830, 885 and either R/S SOC 671 or ANTH 603. In addition, students choosing the thesis option are required to complete six hours of thesis credit (SOC 891) and successfully defend a formal thesis. Students taking the nonthesis option must complete 40 hours of course work including SOC 803, 805, 807, 810, 830, 885 and either R/S SOC 671 or ANTH 603. In addition, students taking the nonthesis option must pass a departmentally administered comprehensive examination. Students must demonstrate competency in basic statistics by either passing a departmentally administered competency examination or obtaining a grade of B in EX ST 801. A six-hour internship in an applied setting is required of all students. The field placement is coordinated by the student, the graduate director and the on-site supervisor. Typically, the internship is completed in the summer between the first and second year of the program, but only after completing a minimum of 12 credit hours of 800-level course work. In exceptional circumstances the graduate coordinator may approve the substitution of six hours of appropriate course work for the field placement when the student has had work experience comparable to the placement.

SOC 601 (R S 601): Human Ecology, 3 cr. (3 and 0)
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 leisure forms; 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)
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)
Sociocultural 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. (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 prevention 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 re-
SOC 803: Survey Designs for Applied Social Research, 4 cr. (3 and 2) 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 life-span 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.

ANTH 603: Qualitative Methods, 3 cr. (3 and 0)
Methods and techniques of qualitative field research including participant observation, ethnographic interviewing, data analysis and report writing. Prerequisite: ANTH 201 or permission of instructor.
College of Engineering and Science

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COLLEGE OF ENGINEERING AND SCIENCE
Thomas M. Keinath, Dean

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 (www.ces.clemson.edu/academic/degrees.htm).

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 chair 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.

Graduate Engineering Education opportunities for practicing engineers are currently available in two disciplines. The Department of Electrical and Computer Engineering offers off-campus graduate courses leading to Master of Science of Master of Engineering degrees through satellite broadcasts. The Department of Mechanical Engineering is offering selected off-campus graduate courses at the University Center in Greenville. Furthermore, graduate courses in both disciplines are offered on-campus late afternoon/early evening, one night a week.

**This program is administered jointly by the College of 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.

SCHOOL OF CHEMICAL AND MATERIALS ENGINEERING
R. Larry Dooley, Director

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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 and 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 artifical 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 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 prosthetic 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: C M E 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 joints, 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 development; 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 bioengineering 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; turbulence; 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 analyses; 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: Selected 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: Biostatistics, 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 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. 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) F
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 instructor.

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 instructor.

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, homeostasis, 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 muscle and nerve functions. Prerequisites: BIOSC 659 and AN PH 660 or permission of instructor.

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

BIOCH 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.

BIOSC 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. Prerequisites: One year each of biology, chemistry and physics or permission of instructor.

BIOSC 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; 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 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.

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 nonparametric 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 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 BIOCH 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; 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 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.

BIOCH 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; 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.

BIOCH 633: General Biochemistry Laboratory I, 2 cr. (0 and 4)
Experiments selected to illustrate current methods used in biochemical research. Corequisite: BIOCH 423 or 431.

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

BIOCH 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: BIOCH 432.

BIOCH 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. Prerequisites: One year each of biology, chemistry and physics 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 BIOCH 459. Students will be introduced to computer-aided data acquisition and computer simulations of physiological function. Prerequisite or Corequisite: BIOCH 459.

BIOCH 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, 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.

BIOCH 668: 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 will be required. Prerequisite: BIOCH 303 or permission of instructor.

BIOCH 670: Animal Behavior, 3 cr. (3 and 0)
Historical and modern developments in animal behavior emphasizing the evolution of behavior, synthesis of theoretical and comparative psychology. Prerequisite: BIOCH 302, or 303 or permission of instructor.

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

BIOCH 672: Ornithology, 4 cr. (3 and 3)
Behavior 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: BIOCH 303 or permission of instructor.

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

BIOCH 676: Comparative Physiology Laboratory, 2 cr. (1 and 2)
Modern classical experimental methods will be used to demonstrate fundamental physiological principles discussed in BIOCH 475; computer-aided data acquisition and manipulation; computer simulations of physiological function. Prerequisite or Corequisite: BIOCH 475.

BIOCH 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: BIOCH 303, organic chemistry or permission of instructor.

ENT 640: Insect Behavior, 3 cr. (2 and 3) F (odd numbered years)
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.

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 squares expectations, variance components analysis, simple and multiple linear regression and correlation, and non-parametric procedures. Prerequisite: Permission of instructor.
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 and 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.Eng. 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 leading to the M.S., M.Eng. 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, mathematical 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 208.

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, glazes and vitreous bonds.

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 620: 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 floculants and defloculants. 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 (BIO 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. Taught as the need arises. Typical topics could include current research in a specific area or technological advances. 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 and Materials 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, whitewares, 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; obtained 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 890: Selected Topics, 1-3 cr. (1-3 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 up to six total hours of credit. Prerequisite: Permission of instructor.

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

CME 892: Doctoral Dissertation Research, credit to be arranged

Chemical Engineering
Charles H. Gooding, Chair, Department of Chemical Engineering

<table>
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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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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 CME 820, 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 12 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 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, antibiotics 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: Biosystems Engineering majors take B E (BIOSC) 430, MIBI 305 and BIOCH 301; Chemical Engineering majors take CH E 312 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, E E 307 and 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 physical systems; dynamic control; 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 governing equations; solution of steady and unsteady-state 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; general 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 (EE&S 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 stressing applied 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; 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 (TC 820): Composite Polymeric 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 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; azotrop 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, descriptions of intermolecular forces, gas-liquid and liquid-liquid critical phenomena, theories of interfacial phenomena and adsorption, statistical mechanics of polymeric systems, statistical mechanics of polydisperse 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 880: 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 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: Doctor of Philosophy Thesis Research, credit to be arranged

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 six research hours for the M.S. degree or the required 30 research credit hours for the Ph.D. degree.

CH E 894: 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

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, semiconductors 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 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 materials 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 adviser when making the decision): MTHSC 806, MAT E 811, MAT E 826, MAT E 895, EX ST 801 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 applications 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 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 810 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 618: 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.

C M E 619: 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.

C M E 802: 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 the polymer science to analyze fiber/matrix wetting and adhesion. Prerequisite: CH E 224 or permission of instructor.

C H E 612: Polymer Engineering, 3 cr. (3 and 0) F
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 302 or permission of instructor.

C H 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.

C H 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.

C H 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.

C H 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 the polymer science to analyze fiber/matrix wetting and adhesion. Prerequisite: CH E 224 or permission of instructor.

C H E 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.

C H E 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 381, 332 or permission of instructor.

CH 811: Analytical Chemistry, 3 cr. (3 and 0) F
Graduate-level overview 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 Schroedinger 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.

ECE 606: Introduction to Microelectronics Processing, 3 cr. (3 and 0)
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: ECE 320. Corequisite: MTHSC 311 or 434.

ECE 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.

ECE 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.

ECE 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; analysis and models of Schottky diode, MIS diode, MOSFET, charge coupled devices and solar cells; charge control concepts, transient time effects, surface-type devices and practical aspects of device process. Prerequisites: ECE 404 and 406/406.

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 stress-strain relations for elastic material; two-dimensional problems; 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 plate 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: 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: E M 808 or equivalent or permission of instructor.

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 calculations, variance components analysis, simple and multiple linear regression and correlation, and nonparametric procedures. Prerequisite: Permission of instructor.

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; use of standard computer programs for selected analyses. Prerequisite: EX ST 801.

E M 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 viscosity flow; expectations; variance components analysis, simple and multiple linear regression and correlation, and nonparametric procedures. Prerequisites: Graduate standing and permission of instructor.

E M 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.

E M 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.

E M 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.
MTHSC 208: 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 808: 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.

PHYS 646: Solid State Physics I, 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 655: Quantum Physics I, 3 cr. (3 and 0)
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)
Continuation of PHYS 655; application of principles of quantum mechanics as developed in PHYS 655 to atomic, molecular, solid state and nuclear systems. Prerequisite: PHYS 655.

PHYS 811: 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.
ENvironmental Science and Policy

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 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

Alan W. Elzerman, Chair, Department of Environmental Engineering and Science

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<th>Major</th>
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<tr>
<td>Environmental Engineering</td>
<td>M.Engr., M.S.</td>
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<td>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 solution of environmental problems in natural and engineered systems.

The M.Engr. 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.S. candidates or a special problem report for M.Engr. 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 602, 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 wastewater treatment systems. Prerequisite: Junior standing in engineering or consent of instructor. Corequisite: E M 320, C E 341, CH E 311 or permission of instructor.

EE&S 602: Water and Waste Water Treatment Systems, 3 cr. (3 and 0) S
Fundamental principles of engineering and science; considerations and operational procedures of the unit operations and processes employed in water and waste water treatment; physiochemical and biological treatment techniques; introduction to the integration of unit operations and processes into water and waste water treatment systems. Prerequisite: E M 320, C E 341, CH E 311 or permission of instructor.

EE&S 608 (B E 608) (CS ENV 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 trips 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 or permission of instructor.

EE&S 660: Environmental Risk Assessment, 3 cr. (3 and 0)
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; methods for analyzing; and the 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 system 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.
EES 686: Pollution Prevention and Industrial Ecology, 3 cr. (3 and 0) F
Pollution prevention technology; the role of pollution prevention within a corporation; source reduction and recycling; pollution prevention assessment; treatment to reduce disposal; life-cycle assessment; design for environment; industrial ecology. An emphasis will be placed on case studies. Prerequisites: Senior standing in College of Engineering and Science.

EES 701: Special Problems, 1-6 cr. (1-6 and 0) F
Environmental engineering problems selected to meet the interests and experience of student and instructor; formal report required. Restricted to Master of Engineering students. Graded on a pass/fail basis.

EES 802: Environmental Engineering Principles, 3 cr. (3 and 0) F
Fundamental principles required for simulation and modeling of environmental engineering processes; mass transfer, reactor kinetics, simulation techniques and applications to various natural and engineered systems.

EES 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: EES 803 and 843.

EES 804: Biocatalytic Operations in Wastewater Treatment Systems, 3 cr. (3 and 0) S
Principles of biocatalytic operations used in wastewater treatment; modeling of ideal biocatalytic reactors and design criteria for aerated lagoons, activated sludge, trickling filters, rotating biological contactors, nitrification, denitrification and digestion. Prerequisites: EES 802 and 851.

EES 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. Corequisite: EES 803 or 804.

EES 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/wastewater or a hazardous/toxic waste. Prerequisites: EES 803 and 804.

EES 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: EES 803 and 843.

EES 808 (GEOL 808): Groundwater Modeling, 3 cr. (3 and 0) N
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.

EES 809 (GEOL 809): Subsurface Remediation Modeling, 3 cr. (3 and 0) N
Lectures and computer exercises involving subsurface remediation methods including groundwater flow, soil vapor extraction, steam flooding and a variety of other techniques; modeling flow of multiphase and multiphase mixtures in porous medium. Prerequisite: GEOL/EES 808 or permission of instructor.

EES 810 (GEOL 810): Analytical Methods for Hydrogeology, 3 cr. (3 and 0) N
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.

EES 812: Environmental Nuclear Engineering, 3 cr. (3 and 0) F
Environmental aspects of nuclear technology emphasizing reactor systems 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: EES 610 and permission of instructor.

EES 813: Environmental Radiation Protection Laboratory, 1 cr. (0 and 3) F
Continuation of EES 611; advanced experiments in radiation detection, radiation protection, health physics and environmental monitoring. Prerequisites: EES 611 and permission of instructor.

EES 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.

EES 832: Air Pollution Meteorology, 3 cr. (3 and 0) F
Applications of meteorology to air pollution; micrometeorology; plume rise modeling; atmospheric diffusion; deposition and washout of pollutants; air chemistry; applications of diffusion modeling to air quality planning. Prerequisite: Permission of instructor.

EES 833: Air Pollution Control Systems, 3 cr. (3 and 0) S
Principles and design of air pollution control equipment including mechanical collectors, electrostatic precipitators, baghouse filters, wet scrubbers, adsorbers and incinerators. Prerequisite: EES 430/630 or permission of instructor.

EES 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 nitrated energetic compounds; biotransformations of metals; biodegradation principles applied to the development of bioremediation technologies including intrinsic, in situ and on-site engineered approaches. Prerequisite: EES 851.

EES 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.

EES 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.

EES 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 EES 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 treat- ment systems; current investigative and study techniques; nature, fluxes and controlling processes 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 and Wetland Hydraulics, 3 cr. (3 and 0) F
The hydraulics of subsurface water including hydraulic head and gradient concepts, Darcy's Law, saturated/unsaturated flow, flow in aquifers and aquitards, flow to wells, and interactions with surface water in wetlands, including discharge and development of seepage faces. Mathematics is at the level of elementary ordinary and partial 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 891: Doctoral Dissertation Research, credit to be arranged, F, S

Environmental Toxicology

Environmental Toxicology is the scientific study of chemical, physical and the ecological effects of these stimuli on living systems and their external and internal physical, chemical and biological integrity. This program emphasizes the metabolism of contaminants, their decomposition, fate and effects in aquatic and terrestrial environments. This interdisciplinary program provides a strong background in fundamental environmental toxicology and ecotoxicology. The program is in the School of Natural Resources and collaborates with several other programs across the university. This program is administered jointly by the College of Agriculture, Forestry and Life Sciences and 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, environmental chemistry, biochemical and mechanism 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 credit 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 College of Environmental Science, 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.

See the College of Agriculture, Forestry and Life Sciences for course listings for this program.

Hydrogeology

Richard D. Warner, Chair, Department of Geological Sciences

Major Degree
Hydrogeology M.S.

The Master of Science in hydrogeology is an interdisciplinary program that focuses on groundwater geology and subsurface remediation and draws 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 will be required to correct deficiencies in their geological education during the first year. Specifically, GEOL 101/103 (Physical Geology), GEOL 202/203 (Structural Geology), GEOL 306 (Mineralogy), and a course in petrology (GEOL 314 or GEOL 316 or an equivalent) or GEOL 413 (Stratigraphy) are required. Students entering this program should also have a strong mathematics background; nor-
mally, 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 of subsurface NAPL contamination and remediation. For students on leave from industry, a special non-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 courses including 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 seismic geophysical surveys. Prerequisite: GEOL 101 or permission of instructor; PHYS 208 or 221 is 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 or 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 geological data emphasizing the analysis of spatially and temporally distributed variables and unique aspects of geological variables; methods of sampling geological data, quantitative procedures for reducing the dimensionality of geological 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 geological techniques to data acquisition and interpretation; prediction of fluid occurrence and flow by integrating results of subsurface analysis.

GEOL 808 (EE&S 808): Groundwater Modeling, 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) N
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 multiseepage and multicomponent mixtures in porous medium. Prerequisite: GEOL/EE&S 808 or permission of instructor.

GEOL 810 (EE&S 810): Analytical Methods for Hydrogeology, 3 cr. (3 and 0)
Analytical and 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.
SCHOOL OF MECHANICAL AND INDUSTRIAL ENGINEERING

Benjamin L. Sill, Director

Engineering Graphics

Benjamin L. Sill, 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 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, dynamic balancing, and multi-degree of freedom systems with lumped parameters. Prerequisites: E M 202, 304, MTHSC 208.

E M 829: Energy Methods and Variational Principles, 3 cr. (3 and 0)
Application of variational principles in solid mechanics problems; virtual work; Castiglione'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 concentration 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, Paris' 
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: 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**

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**Industrial Engineering**

Deburt L. Kimbler, Chair, Department of Industrial Engineering

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<tr>
<th>Major</th>
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<td>Industrial Engineering</td>
<td>M.S., Ph.D.</td>
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Industrial engineers design, improve and install systems that integrate humans, information material and resources to produce goods and services optimally. Success demands that principles of the mathematical, physical and social sciences must be seamlessly meshed with engineering analysis and design. The focus areas of our graduate program are human factors/ergonomics, quality engineering and systems design. Students with a baccalaureate degree in engineering, the physical sciences, mathematics or related majors with a strong mathematical background may be admitted into the program. Entering graduate students are assumed to have competency in calculus, linear algebra, differential equations, probability and statistics, calculus-based physics and computer programming. Admitted students without this background will be required to successfully complete additional courses, some of which may not carry graduate credit. Students admitted to the M.S. program may select a thesis or nonthesis option. Students in the thesis option must complete a minimum of 30 graduate credit hours of course work including six graduate credit hours of master's thesis research. Students in the nonthesis option must complete a minimum of 36 graduate credit hours of course work.

The Ph.D. program is designed to provide the student a comprehensive knowledge of the field of industrial engineering and a mastery of the methods of research. A minimum of 48 semester graduate credit hours of course work beyond a baccalaureate degree is required. Since the dissertation is mandatory for all Ph.D. candidates, 18 graduate credit hours of doctoral research are required, exclusive of any research credits earned at the master's level. Comprehensive and final examinations are required.

**E I 652: Reliability Engineering, 3 cr.**
(3 and 0)
Probabilistic approach to assessing system reliability; methods for analyzing serial, parallel and complex systems; reliability life testing and its acceleration; essential elements of maintainability are identified and related to system availability. **Prerequisites:** MTHSC 206 and 302 or permission of instructor.

**E I 660: Quality Improvement Methods, 3 cr.**
(3 and 0)
Modern quality improvement techniques presented in an integrated, comprehensive context. **Prerequisite:** Senior standing.

**E I 661: 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.

**E I 665: 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.

**E I 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.

**E I 684 (B E 684) (E&ES 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.

Emphasis on 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.

**E I 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.

**E I 686: Production Planning and Control, 3 cr.**
(3 and 0)
Fundamentals of forecasting demand, scheduling production and controlling the movement and storage of materials associated with production; state-of-the-art manufacturing techniques. A design project is required. **Prerequisites:** I E 380 and 384.

**E I 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:** I E 600 or permission of instructor.

**E I 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.

**E I 693: Industrial Ergonomics and Automation, 3 cr.**
(2 and 3)
Physical ergonomics and ergonomics in industrial settings, including work physiology, the physical environment, automated systems and hybrid work systems. **Prerequisite:** I E 210 or permission of instructor.

**E I 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.

**E I 692: Design Topics in I E, 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: classical nonlinear 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, SLAM and/or SIMAN. Prerequisite: Introductory statistics or permission of instructor.

I E 809 Model Systems Under Risk, 3 cr. (3 and 0)
The application of probabilistic methods to engineering problem solving and decision making. Cases are presented that illustrate the use of Markov chains, queuing processes and other stochastic models in practice. Prerequisite: MTHSC 302 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, Mitten'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 861.

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 I E, 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 6)
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 I E, 1-3 cr. (1-3 and 0)
Selected topics in industrial engineering emphasizing new developments in system 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
Mechanical Engineering

Richard S. Figliola, Chair, Department of Mechanical Engineering

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<th>Major</th>
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<tr>
<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, mechatronics and dynamics, materials, robotics and vibrations) or thermal/fluid 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: Mechatronics System Design, 3 cr. (3 and 0)
Mechatronics integrates control, sensors, actuators, and computers to create a variety of electromechanical products. Course study includes concepts of design, appropriate dynamic system modeling, analysis, sensors, actuating devices, and real-time microprocessor interfacing and control. Case studies, simulations, and projects are used to exemplify the system design principles. Prerequisite: M E 305 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: M E 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: M E 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, psychrometric charts, heating and cooling coils, solar radiation, heating and cooling loads, insulation systems. Prerequisites: M E 320 and M E 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 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
software. 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 heat and fluid 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
state 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 of feedback control systems, including the design of
controllers and interconnection of systems; feedback design using state variables;
study of stability, performance, robustness, and sensitivity analysis. 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 and Radiation
Heat Transfer, 3 cr. (3 and 0)
Fundamental concepts related to conduction and radiation heat transfer. Analytical
methods for steady and transient conduction heat transfer in one and two
physical dimensions; radiation exchange between surfaces with and without
radiatively participating media; combined conduction and radiation heat transfer. Prerequisites: M E 304 or equivalent and graduate standing.

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
to work on. They learn the 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 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 pheno-
mena (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 856 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 a mono-object; 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 854 or permission of instructor.

M E 861: Materials Selection in
Engineering Design, 3 cr. (3 and 0)
Advanced study of various physical, chemical and mechanical materials properties which govern the selection of materials in engineering design; case studies of materials selection in design with metals, ceramics, polymers and composites is presented. Prerequisite: Graduate standing.

M E 890: Engineering Project, 1-3 cr.
(0 and 3-9)
Comprehensive analytical and/or experimental treatment of phenomena of cur-
rent interest in mechanical engineering emphasizing modern technological prob-
lems. 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

Richard V. Gregory, Director, School of Textiles, Fiber and Polymer Science

Major Degree
Textiles, Fiber and Polymer M.S., Ph.D.
Science

Applicants for the M.S. degree must have a bachelor's degree in textile chemistry, textile science, the general sciences, engineering or a related discipline, and must have training in chemistry, physics and mathematics.

The major area of study is normally fiber and polymer chemistry or physics, dye chemistry, textile science, textile materials formation science, composite materials or other areas of textile, fiber and polymer science. The minor area of study is usually in chemistry, physics, engineering, computer science, life sciences or mathematics. Each M.S. candidate must complete an independent scientific or technical investigation and formally report and defend the methodology, results and conclusions in a thesis. A minimum of 24 credit hours of course work and six credit hours of research is required for the M.S. degree.

Applicants for the Ph.D. degree should already have a M.S. degree. 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 by standing special examinations in these areas. 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 II; and T C 812.

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 in a dissertation.

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, inclusion of 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. Prerequisite: 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 are 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 inter-relationships 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 nontechnical 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 relationships 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 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 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 laminated 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 adviser.

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.

ASTR 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.

 Biosystems Engineering

John C. Hayes, Chair, Department of Agricultural and Biological Engineering

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<th>Major</th>
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<tr>
<td>Biosystems Engineering</td>
<td>M.Engr., M.S., Ph.D.</td>
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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. Graduate programs in biosystems engineering 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 relating 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 biosystems engineering. Course work, in addition to biosystems engineering, consists of mathematics, physics, chemistry, statistics, and biological and engineering sciences.

Candidates 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) (CS ENV 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 865: Instrumentation for Biosystems Engineers, 3 cr. (2 and 3)
Modern instrumentation techniques for biosystems emphasizing laboratory use of equipment; performance 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 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 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 metabolism; design and analysis of reactors for microbial growth and enzyme-catalyzed reactions; considerations of scale-up, mass transfer and sterilization during reactor design. Prerequisite: Agricultural engineering majors take BE (BIOSC) 430 and MICRO 305, BIOCH 301; chemical engineering majors take CH E 312 as prerequisite and CH E 450 as corequisite.

B E 650: Structural Design for 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, chemosomotic 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.

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. Prerequisites: B E 333, E M 304, C E 341 and M E 310.

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 covered by seminar with instructor and by invited lecturers; current environmental and/or resource conservation issues. Prerequisites: Senior or graduate standing, permission of instructor.

B E 658 (BIOSC 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.

B E 684 (EE&S 684) (I E 684): Municipal Solid Waste Management, 3 cr. (3 and 0)
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 a 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 radiation 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. Prerequisites: B E 333, E M 304, C E 341 and M E 310.

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

Chemistry
Adolph L. Beyerlein, Chair, Department of Chemistry

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<tr>
<th>Major</th>
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<td>Chemistry</td>
<td>M.S., Ph.D.</td>
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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)
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)
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 rotary 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, ESP, 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) F
Theory and experimental study of electrochemical thermodynamics, electroplating 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) F
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 421/621 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: 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 energies 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 Schrödinger 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; Mössbauer spectrometry and tracer analysis.

CH 841: Chemical Applications of NMR Spectroscopy, 3 cr. (2 and 2) F
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 two-dimensional methods. Prerequisite: CH 331 and 332 or permission of instructor.

CH 851: Graduate Student Seminar, 1-2 cr. (1-2 and 0) F, S
Students and faculty review current topics in chemistry. May be taken more than one semester.

CH 852: Departmental Seminar, 1-2 cr. (1-2 and 0) F
Off campus speakers are invited to present aspects of their research to the chemistry faculty and graduate students every week during the academic year. Some of these talks may form the basis for cumulative examination questions. Attendance is mandatory. The course may be taken more than one semester. Prerequisite: An approved bachelor's degree.

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 901: 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 902: 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 903: 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

<p>| James K. Nelson Jr., Chair, Department of Civil Engineering |</p>
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<tr>
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<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 systems. A program of study may also encompass course work in several related interdisciplinary fields such as engineering mechanics or 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. The thesis option requires 30 credit hours, six of which are thesis research. All graduate students are required to complete C E 995.

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)
Introduction to the design of structural elements for masonry buildings.Lintels, walls, shears walls, columns, pilasters and retaining walls are incuded. Reinforced and unreinforced elements of concrete or clay masonry are designed by allowable stress and strength design methods. Introduction to construction techniques, materials and terminology used in masonry. Prerequisite: C E 402 or permission of instructor.

C E 607: Wood Design, 3 cr. (3 and 0)
Introduction to wood design and engineering: properties of wood and wood-based materials; design of beams, columns, walls, roofs, panel systems and connection. Prerequisites: C E 300 and C E 402 or C E 406.

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 311.

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 patterns 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 Management 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 331 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 and EX 3T 301.

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 647: Stormwater Management, 3 cr. (3 and 0)
Evaluation of peak discharges for urban and rural basins, design of highway drain- age structures such as inlet and culverts; stormwater and receiving water quality; best management practices, detention and retention ponds and erosion and sediment control. Prerequisite: C E 342. Corequisite: EE&S 401 or permission of instructor.

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 682: Groundwater and Contaminant Transport, 3 cr. (3 and 0) S
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 transformations. Prerequisite: C E 341. 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 planar 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; advanced 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)
Study of civil engineering failures including analyses 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 subbases; 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 821 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. Prerequisites: 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 en-
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 procedures; extensive hands-on use of the microcomputer. Prerequisites: C E 433/633 and 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; numeric 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 889: 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.
ECE 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: ECE 320. Corequisite: MTHSC 311 or 434.

ECE 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: ECE 329, ECE 352 and MTHSC 419.

ECE 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: ECE 360, 380.

ECE 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: ECE 321, 360 and 380. Corequisite: MTHSC 434 or permission of instructor.

ECE 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: ECE 321, 330, 360, 371, 381.

ECE 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. Prerequisite: ECE 371.

ECE 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 ECE 250 or 272 or permission of instructor.

ECE 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 microwaves circuits. Experimentation with various types of circuits is provided by laboratory projects. Prerequisite: ECE 321. Corequisite: MTHSC 311 or 434.

ECE 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: ECE 302 or 409, 371 or permission of instructor.

ECE 636: Microwave Circuits, 3 cr. (3 and 0) F
Analysis of microwave networks comprising transmission lines, waveguides, passive elements, interconnects and active solid-state microwave circuits. Use of modern CAD tools to design RF/Microwave passive/active networks. Fabrication of typical circuits. Prerequisite: ECE 381 or equivalent. Corequisite: MTHSC 311 or 434.

ECE 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.

ECE 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 monomode and multimode fibers; fabrication and measurement. Prerequisite: ECE 381. Corequisite: MTHSC 434 or permission of instructor.

ECE 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: ECE 272, 317 or MTHSC 400 or equivalent.

ECE 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: ECE 329, 352.

ECE 646: Antennas and Propagation, 3 cr. (3 and 0) S
Theoretical and practical aspects of antennas design and utilization, input impedances, structural considerations and wave propagation. Prerequisites: ECE 330, 381 or 436, MTHSC 311 or 434.

ECE 653: Software Practicum, 3 cr. (1 and 6)
Student must design and implement a software system that satisfies both a requirement and specifications document. The resulting system will be tested for compliance. Prerequisites: ECE 329, 352.

ECE 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.

ECE 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.

ECE 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, computer control, artificial limbs, etc. Prerequisites: ECE 302 or 330 or 409 and 371, MTHSC 311 or 434 or permission of instructor.

ECE 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.

ECE 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.

ECE 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.

ECE 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: ECE 434/634.

ECE 811: Integrated Circuit Design, 3 cr. (2 and 2) 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 standard cells; systems design, testing and packaging. Prerequisite: ECE 459/659.

ECE 816: Electric Power Distribution System Engineering, 3 cr. (3 and 0) Radial circuit analysis techniques, feeder and transformer modeling, load modeling, loss minimization and voltage control, causes of power quality problems, motor starting analysis, strategies for analyzing impacts of disturbances. Prerequisites: ECE 418 and 419 or permission of instructor.

ECE 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: ECE 317 and 330 or permission of instructor.

ECE 824: Power System Protection, 3 cr. (3 and 0) Coordination of power system protection components including microprocessor based relay-adaptive protection of power system, power system disturbance identification, and system restoration following a major disturbance. Prerequisites: ECE 418 or permission of instructor. Corequisite: MTHSC 434 or permission of instructor.

ECE 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: ECE 380 and 381 or their equivalents.

ECE 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.

ECE 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: ECE 830 or permission of instructor.

ECE 841: Distributed Computing and Networks, 3 cr. (3 and 0) 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: ECE 438/638.

ECE 842: Computer Architecture, 3 cr. (3 and 0) 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: ECE 429 or equivalent.

ECE 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: ECE 467/667.

ECE 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.

ECE 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: ECE 467.

ECE 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: ECE 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. Prerequisites: ECE 438/638 or CPSC 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 as 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 OPS5. 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-Chandhuri types and burst-error correcting codes; problems of implementation and decoding. Prerequisite: ECE 317 or equivalent.

ECE 860: Advanced Coding Theory, 3 cr.
(3 and 0)
Introduction to convolutional codes and trellis-coded modulation. Topics include: code generation and representation, distance properties, decoding techniques, performance analysis, multidimensional codes and lattice theory, and coding for fading channels; applications to wireline communications and mobile communications are considered. Prerequisites: ECE 828 and 857.

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

<p>| John C. Peck, Chair, Department of Computer Science |</p>
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<thead>
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<th>Computer Science</th>
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<td>M.S., Ph.D.</td>
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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 and 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 to 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 implementation of language 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 and 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 related to the design of on-line 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 360.

CP SC 663: On-Line Systems, 3 cr.
(3 and 0)
Design and implementation of transaction processing systems; basic communications concepts; survey of commer-
fully 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)
Scripting systems, motion control, articulated figures, forward and inverse kinematics, soft object deformation, inbetween 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) S
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) S
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, processor 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 grammars 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; 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 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) N
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 891: 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

Electrical Engineering

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Students in electrical engineering may direct their programs toward the fields of communications/digital signal processing, computer communications, controls/robotics, computational electromagnetics, electronics or 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 course work must be completed. The Masters of Engineering program is available for students in the special programs and has the same requirements as the M.S. thesis option except the thesis is replaced by an engineering report.

The Ph.D. requires at least 24 credit hours of graduate course work beyond the master's degree. 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.

The department participates in the university telecampus program which serves off-campus students within South Carolina. Further information is available through the Office of Off-Campus, Distance and Continuing Education at 1-888-253-6766. The department Web page at www.ece.clemson.edu/index.htm provides more detailed current information related to the degree program requirements and application.

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.
ECE 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: ECE 409.

ECE 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: ECE 329 and MTHSC 419.

ECE 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: ECE 360 and 380.

ECE 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: ECE 321, 360 and 380. Corequisite: MTHSC 434 or permission of instructor.

ECE 622: Operational Amplifier Circuits, 3 cr. (2 and 2) S
Analysis and design of circuits, both analog and digital, using operational amplifiers. Prerequisite: ECE 321. Corequisite: MTHSC 311 or 434.

ECE 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: ECE 352 and 371.

ECE 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: CPSC 230 or ECE 250 or 272 or permission of instructor.

ECE 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: ECE 317 or MTHSC 400, ECE 330, MTHSC 311 or 434 or permission of instructor.

ECE 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, waveform generation, memory elements, switching and logic circuits. Experiments with various types of circuits is provided by laboratory projects. Prerequisite: ECE 321. Corequisite: MTHSC 311 or 434.

ECE 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: ECE 321. Corequisite: MTHSC 311 or 434.

ECE 634: Power Electronics, 3 cr. (3 and 0) F
Electronic devices and systems designed to control or regulate large amounts of power including SCR application to inverters, motors controls, high-current switching systems, voltage stabilizers, and other power applications of electronics. Prerequisites: ECE 321 and 360. Corequisite: MTHSC 434 or permission of instructor.

ECE 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: ECE 381 or equivalent. Corequisite: MTHSC 311 or 434.

ECE 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.

ECE 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: ECE 381. Corequisite: MTHSC 434 or permission of instructor.

ECE 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: ECE 322, 317 or MTHSC 400 or equivalent.

ECE 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: ECE 329 and 352.

ECE 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: ECE 330, 381 or 436, MTHSC 311 or 434.

ECE 656: Fundamentals of Robotics, 3 cr. (3 and 0) F
Introduction to the fundamental mechanics and control of robotic systems including their application to advanced automation. Topics 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.

ECE 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 logic, microprocessors and systems design considerations, testing and packaging. Prerequisite: ECE 321. Corequisite: MTHSC 311 or 434.

ECE 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 systems and digital computers, system design considerations; testing and packaging. Prerequisites: ECE 262, MTHSC 311, 434, or permission of instructor.
ECE 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.

ECE 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.

ECE 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.

ECE 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.

ECE 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.Engr.) degree. Graded on a pass/fail basis. May be repeated for up to six hours total credit.

ECE 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.

ECE 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: ECE 434/634.

ECE 804: Methods of Applied Optimization and Optimum Control, 3 cr. (3 and 0)
Methods of optimizing systems with and without dynamics including linear programming, nonlinear programming, integer programming, gradient and variational calculus, minimum principle, principle of optimality and dynamic programming. Corequisite: MTHSC 653.

ECE 805: Methods of State and Parameter Estimation of Stochastic Systems, 3 cr. (3 and 0)
State and parameter estimations of both linear and nonlinear continuous-time and discrete-time systems including model identification: Kalman and Weiner filters, fixed-interval, fixed-point and fixed-lag smoothers, stochastic approximation estimation, nonlinear estimation by statistical linearization and sensitivity analysis of Kalman filters. Corequisite: MTHSC 654.

ECE 807: Computer Methods for Power Systems Analysis, 3 cr. (3 and 0)
Electric power system operation; development of models of transmission line components and networks; computer methods for solving linear and nonlinear systems of network equations; operating problems in load flow, scheduling and economic dispatch. Prerequisite: ECE 418/618.

ECE 811: Integrated Circuit Design, 3 cr. (2 and 2)
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 standard cells; systems design, testing and packaging. Prerequisite: ECE 459/659.

ECE 817: Power System Transients, 3 cr. (3 and 0)
Electrical transients in power systems; frequency domain and time domain techniques for power systems transient analysis; capacitor switching, load switching, fault-induced transients, line reclosing and single pole switching. Prerequisite: Permission of instructor.

ECE 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: ECE 317 and 330 or permission of instructor.

ECE 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 observation; estimates and their properties; signal resolution. Prerequisite: ECE 820.

ECE 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 428/628 or equivalent.

ECE 821: Digital Communication Systems II, 3 cr. (3 and 0)
Continuation of ECE 820.

ECE 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.

ECE 823: Integrated Circuit Technology, 3 cr. (3 and 0)
Physical and chemical principles underlying the major processing operations used in the fabrication of integrated circuits; semiconductor devices, process simulation, diagnostic testing, and factors affecting device yield and reliability. Prerequisite: Permission of instructor.

ECE 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.

ECE 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: ECE 380 and 381 or their equivalents.

ECE 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: ECE 830.

ECE 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: ECE 830.

ECE 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, interference and reflection by classical and numerical techniques of the relations between structure and performance, gain and terminal conditions. 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 methods of multipoles and periodic structures. Prerequisite: 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 electrodynamics, 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 modeling 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 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. (3 and 0) S Fundamental issues that arise in the composition of logic elements into computer systems; design and analysis of processors, busses, 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) F 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) 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.

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: Computer System Design and Operation, 3 cr. (3 and 0) Methods of designing and operating robotic 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 travel using artificial intelligence. Prerequisite: E C 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-Chandhuri 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 system disturbances. Prerequisites: E C E 418/618 and permission of instructor.
ECE 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: ECE 418/618.

ECE 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: ECE 418/618 and 419/619.

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 891: Doctoral Dissertation Research, credit to be arranged

**Fine Arts in Computing**

Mark McKnew, Program Coordinator, Fine Arts in Computing

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<tr>
<th>Major</th>
<th>Degrees</th>
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<tr>
<td>Fine Arts in Computing</td>
<td>M.F.A.</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 193.

**Management Science**

Peter R. Nelson*, Program Coordinator, Department of Management Sciences

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<tr>
<th>Major</th>
<th>Degrees</th>
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<tr>
<td>Management Science</td>
<td>Ph.D.</td>
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See the College of Business and Public Affairs for information on this program.

**Mathematical Sciences**

George J. Fix, Chair, Department of Mathematical Sciences

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<th>Major</th>
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<tr>
<td>Mathematical Sciences</td>
<td>M.S., Ph.D.</td>
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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, multifactor 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; intro-

*Dr. Nelson is a faculty member of mathematical sciences.*
MTHSC 610: 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 660: Discrete Mathematical Analysis I, 3 cr. (3 and 0)
Basic properties of the real number system, sequences and limits; continuous functions, uniform continuity and convergence; integration, differentiation, functions of several real variables, implicit function theory. Prerequisite: MTHSC 206.

MTHSC 663: Introduction to 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 670: 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 670: Modern Mathematics for Elementary School Teachers — Algebra, 3 cr. (3 and 0)
Continuation of algebra; propositional logic; elementary and secondary education. Prerequisite: MTHSC 206.

MTHSC 670: Modern Mathematics for Elementary School Teachers — Linear Algebra, 3 cr. (3 and 0)
Laplace transforms, matrix methods, systems of linear equations, vector spaces and determinants; vector spaces and transformations; eigenvalues. Restricted to graduate students in secondary education.

MTHSC 721: Modern Mathematics for Elementary School Teachers — Statistics, 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 722: Modern Mathematics for Elementary School Teachers — Number Theory, 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 723: Modern Mathematics for Elementary School Teachers — Geometry, 3 cr. (3 and 0)
Continued study of geometry 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 724: Modern Mathematics for Elementary School Teachers — Calculus, 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, and electronic switching circuits. Restricted to graduate students in secondary education.

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 analysis. 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 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 computers 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-, two- 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 804: Statistical Inference, 3 cr. (3 and 0) Principle topics include sampling distributions, maximum likelihood estimation and likelihood ratio tests, asymptotic confidence intervals for Binomial, Poisson and Exponential parameters, two sample methods, nonparametric tests, ANOVA, regression and model building. Prerequisite: MTHSC 400/600 or equivalent or permission of instructor.

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 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); 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, 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 819: Multicriteria Optimization, 3 cr. (3 and 0) S
Theory 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) S
Topological concepts; complex integration; local analytic properties of analytic functions; power series; representation theories; 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 differentiable and difference equations. Prerequisites: MTHSC 454/654 and 311 or 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 Systems Neural Networks, 3 cr. (3 and 0) S
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) S
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, WKB 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 localization; singular value decompositions; definite matrices. Prerequisite: MTHSC 311, 453 or 463.

MTHSC 854: Theory of Graphs, 3 cr. (3 and 0) S
Connectedness; 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 sequences and 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 functions and differential equations; integral equations and overdetermined linear systems; eigenvalue problems; approximation using splines. Prerequisites: MTHSC 453 and 460.
MTHSC 863: Digital Models I, 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. Prerequisite: MTHSC 403/603 or equivalent.

MTHSC 882: Monte Carlo Methods, 3 cr. (3 and 0) F
Random number generators, discrete and continuous random variate generation and approximations, random vector generation, Monte Carlo integration, variance-reduction techniques. Prerequisites: MTHSC 603 and 800.

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 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 907: 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 956: 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 957: Selected Topics in Analysis, 1-3 cr. (1-3 and 0) F
Advanced analysis topics from current problems of interest. May be repeated for credit, but only if different topics are covered.

MTHSC 958: 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 959: Selected Topics in Algebra and Combinatorics, 1-3 cr. (1-3 and 0) F
Advanced topics in algebra and combinatorics from current problems of interest. May be repeated for credit, but only if different topics are covered.

MTHSC 986: Selected Topics in Geometry, 1-3 cr. (1-3 and 0)
Advanced topics in geometry from current problems of interest. May be repeated for credit, but only if different topics are covered.

MTHSC 988: Selected Topics in Operations Research, 1-3 cr. (1-3 and 0)
Advanced topics in operations research from current problems of interest. May be repeated for credit, but only if different topics are covered.

MTHSC 991: Doctoral Dissertation Research, credit to be arranged

Mathematical Sciences

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 departmental 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 continuation 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 nonthesis 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 nonthesis 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 nonthesis 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
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 biochemistry. 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 radiation processes, convection and cloud physics, precipitation processes, hydrodynamic equations of motion and large-scale motion of the atmosphere, numerical weather prediction, atmospheric electricity. Prerequisite: PHYS 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, electrodynamics, 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 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)
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 811: 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 812: Methods of Theoretical Physics II, 3 cr. (3 and 0)
Continuation of PHYS 811: use of integral transforms, integral equations, special functions, calculus of variations and numerical approximations in solutions of physical problems.

PHYS 815 (M E 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.

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 phenomenon; boundary effects; theory of electrons and microscopic phenomena.

PHYS 845: Solid State Physics I, 3 cr. (3 and 0)
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)
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 956: 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
College of Health, Education and Human Development

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SCHOOL OF EDUCATION
Linda Gambrell, Director

The mission of the School of Education is to prepare outstanding, reflective practitioners in education and human resource development through the provision of diverse experiences in content, method and research that empower professionals to be effective members of the communities in which they live and serve.

At the School of Education, we train teachers, counselors and leaders for the P-12 schools and training and development specialists for business and industry.

The School of Education embraces its conceptual framework of empowered professionals educating a diverse world. Empowered professionals utilize the knowledge of curriculum, technology, assessment and instructional/leadership/counseling strategies to effect learning for diverse populations. Clemson University provides resources for courses and clinical experiences in method, research and content knowledge which enable professionals to be reflective practitioners. Such practitioners are knowledgeable, ethical, caring decision makers responding to local, state and world needs.

Clemson University is accredited by the National Council for the Accreditation of Teacher Education (NCATE) and the state of South Carolina for the preparation of educational personnel in South Carolina in early childhood education, elementary education, special education and the following secondary school programs: agriculture, technology education, biological sciences, physical sciences, earth sciences, mathematics, English, history and geography, political science and economics, psychology and sociology, administration and supervision, counseling and guidance services, curriculum and instruction, educational leadership, industrial education, secondary education, special education and vocational/technical education.

In addition, there are programs in human resource development (HRD) at both the undergraduate and graduate levels designed to prepare competent professionals for a variety of education, training and development settings within industrial, business and public sector environments. These HRD programs serve professionals working in the areas of human resource development, management, construction, health occupations, secretarial sciences, graphic communications, transportation, loss control, quality control, information services and personnel management. The HRD specialists graduating from the program are qualified to provide training related to the following areas: skills and technical, management and motivation.

The School of Education has designated a series of courses to meet the growing demand for continual professional development in the state. Courses ED 631-635, ED F 636 and ED SP 636, effective Fall 2000, will be used for recertification and nondegree purposes.

Educational Leadership

Dr. Richard Blackburn, Area Coordinator

Majors

| Administration and Supervision | M.Ed., Ed.D. |

M.Ed., Administration and Supervision Emphasis

The Master’s of Education degree in administration and supervision is designed to provide experienced teachers (at least one year) with preparation as elementary or secondary school administrators or supervisors. The program provides a theoretical foundation in effective educational leadership, blended with insights into the practical exercise of such leadership.

Admission Requirements: Complete application package to the Graduate School should include: a GRE composite score of 1240 or a Miller Analogies Test score of 36; a minimum of one year of teaching experience or equivalent; official transcripts; three letters of recommendation; and an undergraduate GPA of 2.5 overall or 2.70 on the last 60 hours. Program Requirements: This program incorporates the academic requirements for certification as a principal and supervisor in South Carolina. Forty-two (42) hours of graduate credit are required.

Program Core Courses: Students must complete the following core courses including 33 hours in educational administration:

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 courses 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 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 795: School Leadership Information Systems, 3 cr. (2 and 2)
Use of computers and related technologies for decision making by public school leaders; logistics of information management, sources of information, communication with technology and integration of technology into the leadership function.

Students must also take nine hours of other required courses including:

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: Comprehensive 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, core-curriculum, organization, scheduling, planning, management and technology. Prerequisites: ED L 700 and 710.

ED F 778: Experimental and Noneperimental Research Methods in Education I, 3 cr. (3 and 0)
Types of educational research and uses; logical bases of quantitative and qualitative research 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; curriculum administration and educational support services. Prerequisite: EX ST 301 or equivalent or permission of instructor; ED F 808 recommended.

Course Levels: Courses must be taken in sequence within three levels.
Level I consists of ED L 730, ED L 700, ED L 710, and ED L 735. Two of the three must be completed before attempting Level II or Level III.
Level II consists of ED L 705, ED L 720, ED L 725, ED F 778. Two of the three must be completed before attempting Level III courses.

Ed.S., Administration and Supervision Emphasis
The Educational Specialist degree in administration and supervision is designed to provide students with preparation as senior-level school administrators. The program provides the academic requirements for certification as a superintendent in South Carolina. Additionally, it fulfills the certification requirements of states which specify the completion of a nationally accredited two-year program of graduate study leading to certification as a school administrator.

Admission Requirements: Complete application package to the Graduate School should include a master's degree; a GRE composite score of 1280 or a Miller Analogies Test score of 57; official transcripts; three (3) letters of recommendation; and a GPA of 3.25 or better on all previous graduate work.

Program Requirements: A student must be certified as a principal prior to formal admission to the Ed.S. program. Students without certification must fulfill the program requirements for principal certification before they can be admitted to candidacy for the Ed.S. degree. candidacy is defined as the final 21 hours of the program (Level II and Level III courses).

Program Core Courses: Students must complete 90 hours in educational administration including the following core courses:

ED L 805: Advanced Educational Leadership: Theory and Practice, 3 cr. (3 and 0)
Principles and theories of leadership as practiced in the institutional setting. Prerequisites: ED L 700, 715 and 730.

ED L 810: Introduction to School Building Planning, 3 cr. (2 and 2)
Planning of educational facilities from conception of need through utilization of facility. Prerequisite: ED L 700.

ED L 815: The Superintendency, 3 cr. (3 and 0)
Current, in-depth study of the superintendency, including relationships with school boards, faculty, staff and community, for practicing and aspiring educational administrators. Prerequisite: Admission to the educational specialist program or the doctoral program.

ED L 820: Politics of Education, 3 cr. (3 and 0)
Politics of education in the United States including the complex interrelationships among administrators, special interest groups, politicians and knowledge brokers.

ED L 830: Business Management in Education, 3 cr. (2 and 3)
Fiscal management of individual schools and districts, including budgeting, purchasing and accounting for funds. Prerequisites: ED L 700, 725 and 745.

ED L 839: Research Methods in Educational Leadership, 3 cr. (3 and 0)
Development of design, method and procedures for conducting the educational specialist project. Course culminates in the completion and presentation of the project prospectus for approval by the instructor and the student's major advisor. Prerequisites: ED L 800, 805, 820 and permission of instructor.

ED L 840: Field Problems in School Administration and Supervision, 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 850: 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 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.
Course levels: Courses must be taken in sequence within three levels.

- Level I consists of ED L 820, ED L 830, ED L 810, ED L 815.
- Level II consists of ED L 805, ED L 800/950, ED L 839.
- Level III consists of ED L 850, ED L 840, ED L 925.

**Ph.D., Educational Leadership Emphasis**

The Doctor of Philosophy degree in educational leadership is designed to provide students with a strong background in two basic academic areas: educational research and educational leadership. It provides students with competencies and skills needed for effective functioning in a formal leadership capacity in an educational (or related service) organization.

As the highest academic degree granted by Clemson University, the Ph.D. is designed to prepare students to become scholars who can discover, integrate, and apply knowledge. Furthermore, the intent is to produce effective educational administrators. This preparation enables students to understand and critically evaluate existing knowledge in educational leadership. This is accomplished through close association with and apprenticeship to faculty members experienced in research, teaching and administration.

A student admitted to the educational leadership doctoral program must begin course work within one year from the semester of acceptance or re-apply for admission. Students are discouraged from taking more than six (6) hours of doctoral course work prior to being admitted to the program. (This does not preclude the use of courses completed in the EdS degree in educational administration.)

Admission Requirements: Complete application package to the Graduate School should include: A GRE composite score of 1450 (a minimum of 500 on the verbal and quantitative sections); master's degree; official transcripts; three letters of recommendation; and a two-page letter discussing reasons for pursuing the Ph.D. degree. This letter may be used as a writing sample. An interview is optional.

Program Requirements: Graduate programs at the doctoral level must maintain flexibility. The program of study will be developed by the student's program committee and will conform with departmental policy requiring a minimum of 76 graduate credit hours beyond the master's degree, including the 18 hours of research project (ED L 991, Dissertation Research).

Students who have not completed course work prerequisites for entrance into the program in educational leadership must complete such course work as specified by the program committee. All preparatory course work assigned by the program committee must be completed before proceeding with the required program.

Program Core Courses: Students must complete the following core courses: total core semester hours - 28; K through 12 students - 31.

**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 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 989: 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-II.

The following courses can be taken to complete research requirements:

**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. **Prerequisites:** 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. **Prerequisite:** ED F 778, 878 or equivalent.

**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 question is investigated 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.

**EX ST 801: Statistical Methods I, 4 cr. (3 and 3) F, S, SS**

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.

**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 805: Advanced Educational Leadership: Theory and Practice, 3 cr. (3 and 0)**

Principles and theories of leadership as practiced in the institutional setting. **Prerequisite:** ED L 700, 715 and 730.

**ED L 810: Introduction to School Building Planning, 3 cr. (2 and 2)**

Planning of educational facilities from conception of need through utilization of facility. **Prerequisite:** ED L 700.

**ED L 815: The Superintendency, 3 cr. (3 and 0)**

Current, in-depth study of the superintendency, including relationships with school boards, faculty, staff and community, for practicing and aspiring educational administrators. **Prerequisite:** Admission to the educational specialist program or the doctoral program.

**ED L 820: Politics of Education, 3 cr. (3 and 0)**

Politics of education in the United States including the complex interrelationships among administrators, special interest groups, politicians and knowledge brokers.

**ED L 830: Business Management in Education, 3 cr. (2 and 3)**

Fiscal management of individual schools and districts, including budgeting, pur-
ED L 950: 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. Prerequisite: ED L 800, 805 and permission of instructor.

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 915: Educational Planning, 3 cr. (3 and 0)
Systems approach to planning and management, and the measurement and interpretation of performance results.

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, feedback analysis, mathematical modeling, artificial life simulations, game theory, catastrophe theory, social evolution, social morphology and nonlinear theories 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 social, cultural, and political aspects. Prerequisite: Admission to doctoral studies.

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.

Cognates
Cognates are courses from another area of study. As a part of their program of study, each student must complete six graduate semester hours in a field outside education. All six hours must be from the same discipline and approved by the student's graduate committee.

Dissertation
A minimum of 18 credit hours is required for the dissertation.

ED L 991: Doctoral Dissertation Research, credit to be arranged
Internship
All students are required to complete six hours of internship credit.

ED L 995: 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. Prerequisites: ED L 900, 905, 910 and permission of major advisor.

Counseling
Dr. Don F. Keller, Area Coordinator

The Master's in Education in counseling prepares students in one of the following specialty areas: community counseling, elementary school counseling, secondary school counseling and student affairs practice in higher education. Graduate education in the counseling program is designed to help students realize their potential as practicing counselors and administrators, engage in professional relationships, and develop a set of meaningful professional values. To this end, the program reflects current knowledge from lay and professional groups concerning current and projected counseling and human development needs of a pluralistic society. Cultural considerations are emphasized so that the experiences provided will be rewarding and useful in today's ever-changing society.

The faculty of the counseling program is dedicated to educating and training counseling professionals to function in culturally diverse settings. This program utilizes an "integrative practitioner training" model emphasizing development, prevention, enhancement and the diagnosis and remediation of psychological disorders. The programs are designed to provide a challenging, yet supportive, environment that promotes professional orientation, practice and self-awareness.

Clemson University recognizes laboratory settings and field-based experiences as providing the student with (1) a realistic perspective on the field; (2) an integrating experience for knowledge and skills acquired in the classroom; (3) a situation that maximizes self-awareness, self-direction and self-evaluation; and (4) feedback on his/her progress and development.

Clemson University acknowledges the importance of close supervision in practica or internship placements as a means of maximizing student training and preventing inadvertent harm to clients. Practica and internships are designed so that the focus and intensity of supervision will change as students acquire competent beginning, intermediate and advanced skills. The University supervisor provides each supervisee with periodic performance and evaluation feedback throughout the supervised experience. At no point is any student to engage in any field-based practica experience without the permission of the major adviser.

Practica currently require 100 hours and internships 600 hours of on-site counseling activities, a minimum of one hour of individual supervision per week, a formal log of all activities, and regular meetings with the student's supervisor.

Upon completion of 33 hours, students may be given permission by their major adviser to take the comprehensive examination. It is the student's responsibility to have an approved GS-2 form on file with the Graduate
Current counseling students are also required to take and pass the national Counselor Preparation Comprehensive Examination (CPCE). Each examination is highly structured to include all the courses that are required by each program.

Each student is assigned a major advisor chosen from the counseling faculty. It is required that students meet with their advisor at least once a semester to ensure appropriate course sequencing.

Admission Requirements: Complete application package to the Graduate School should include: undergraduate transcript representing GPA of 2.7 overall; or 3.0 for the last 60 hours on a 4.0 scale. If the undergraduate GPA is not met, the GRE must be taken. Students must obtain a composite score of 1350; two recommendation letters; letter of intent; approval of the counseling faculty.

Additional Requirement for community counseling track: a minimum of 12 semester hours of psychology and/or sociology, graduate or undergraduate.

Additional Requirement for school counseling track: a valid professional education certificate.

Additional Requirement for student affairs track: experience in higher education and/or current employment in higher education.

Core Requirements: The student will: develop respect for the dignity and worth of the individual; develop commitment to the fulfillment of human potential; understand educational and counseling processes; gain knowledge in his/her particular field of counseling; develop competence in the application of professional expertise in counseling; gain knowledge of the role and function of professionals in related fields; develop a commitment to inquiry; and develop maturity in self-development.

M.Ed., Community Counseling Emphasis
Students completing the M.Ed. program in counseling with an emphasis in community counseling will demonstrate: an ability to effectively work with community and other agency personnel; an ability to meet qualifications for certification or licensure; understanding and skills related to counseling needs in the environment in which they choose to work; a high degree of self-understanding; an ability to effectively communicate with diverse cultural groups; a knowledge about counseling across the life span; human evaluation and research skills; a high degree of sensitivity and acceptance of others' behavior; an awareness of responsibilities specific to a variety of community agencies; and ethical practices.

Community Counseling Specialty Area (48 semester hours)
I. Area of Specialization (36 semester hours)
ED F 701: Human Growth and Development, 3 cr. (3 and 0)
Theory and research in human development and its impact on the teaching/learning process. Prerequisites: ED 334, 335, 336 or equivalent; classroom teaching experience.
ED F 778: Experimental and Nonexperimental Research Methods in Counseling, 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 808 recommended.
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. Prerequisite: ED C 801 and 802 or permission of instructor.
ED C 810: Theories and Techniques of Counseling, 3 cr. (3 and 0)
Counseling theories and techniques. Prerequisite: ED C 801 and 802 or permission of instructor.
ED C 811: Multicultural Counseling, 3 cr. (3 and 0)
Responsibility of counselors to all people regardless of race, sex, gender, socio-economic status, subculture, etc.; content and theory related to counseling multicultural individuals/groups.
ED C 812: 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 813: Appraisal Procedures, 3 cr. (2 and 2)
Experience in gathering, interpreting and utilizing data as it relates to the individual; especially significant to counselors. Prerequisite: ED F 808 or permission of instructor.
ED C 814: Development of Counseling Skills, 3 cr. (3 and 0)
On-campus experience to help counselors develop communication skills through role-playing activities, audio and videotaping, interviewing, lecture and discussion. Prerequisite or Corequisite: ED C 810.
ED C 815: Group Counseling, 3 cr. (3 and 0)
Experience as a member of a group to aid the student in understanding group dynamics and the role of a group member as a participant and facilitator; emphasis is on small group participation, communication skills and self-understanding. Prerequisite: Permission of instructor.
ED C 816: Introduction to Marriage and Family Counseling, 3 cr. (3 and 0)
Marital 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 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.

II. Field Experiences (nine semester hours)*
ED C 836: Community Practicum, 3 cr. (1 and 6)
Supervised field experiences in counseling and other services in a community agency setting. Prerequisites: ED C 810, 814 or permission of instructor.
ED C 846: Community Counseling Internship, 1-6 cr. (1 and 1-6)
Students apply previous knowledge of counseling theory and techniques in a supervised field experience to professional mental health counseling settings. Prerequisites: EDF 701, ED C 805, 810, 813, 814, 815, 836, and permission of instructor (600 clock hours).

III. Elective (three semester hours)
Under advisement, elective must be approved by program faculty.

Testing Requirements: Upon completion of 33 semester hours in the program, students are eligible to take the program's Comprehensive Examination. This exam is given once every semester and is required for graduation. The Comprehensive Exam consists of two sections: (1) The Counselor Preparation Comprehensive Examination (CPCE), a 160-item multiple-choice test, and (2) comprehensive essay questions. Both sections of the Comprehensive Examination must be passed prior to graduation. Each student is allowed to take the Examination twice. Failure on two administrations results in dismissal from the program.

* Students must take 21 hours before taking the internship.
M.Ed., School Counseling Emphasis

Students completing the M.Ed. program in Counseling will demonstrate: ability to effectively work with students, teachers, administrators and other members of the community; a high level of expertise in counseling appraisal, theory, skills and intervention techniques. Qualification for state and national certification as school counselors: ability to conduct a comprehensive and developmental school guidance and counseling program; a healthy self-awareness and understanding; counseling within the framework of their respective association’s legal and ethical standards; ability to counsel with sensitivity, caring and an appropriate approach in diverse environments; ability to perform in a consultative capacity both within and outside of the school environment.

Elementary School Counseling Specialty Area (48 semester hours)

I. Foundations (nine semester hours)

ED F 701: Human Growth and Development, 3 cr. (3 and 0)
Theory and research in human development and its impact on the teaching/learning process. Prerequisite: ED 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 302 or equivalent; classroom teaching experience recommended.

ED F 778: Experimental and Nonexperimental Research Methods in Education I, 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 808 recommended.

II. Area of Specialization (27 semester hours)

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 810: Theories and Techniques of Counseling, 3 cr. (3 and 0)
Counseling theories and techniques. Prerequisite: ED C 801 and 802 or permission of instructor.

ED C 811: Multicultural Counseling, 3 cr. (3 and 0)
Responsibility of counselors to all people regardless of race, sex, gender, socioeconomic status, subculture, etc.; content and theory related to counseling multicultural individuals/groups.

ED C 812: 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 813: Appraisal Procedures, 3 cr. (2 and 2)
Experience in gathering, interpreting and utilizing data as it relates to the individual; especially significant to counselors. Prerequisite: ED F 808 or permission of instructor.

ED C 814: Development of Counseling Skills, 3 cr. (3 and 0)
On-campus experience to help counselors develop communication skills through role-playing activities, audio and videotaping, interviewing, lecture and discussion. Prerequisite or Corequisite: ED C 810.

ED C 815: Group Counseling, 3 cr. (3 and 0)
Experience as a member of a group to aid the student in understanding group dynamics and the role of a group member as a participant and facilitator; emphasis is on small group participation, communication skills and self-understanding. Prerequisite: Permission of instructor.

ED C 816: 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 820: The School Counselor as Consultant, 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 830: Elementary School Counseling Practicum I, 3 cr. (1 and 6)
Supervised field experience in counseling and other services in an elementary school. Prerequisite: ED C 801, 810, 814 or permission of instructor (100 clock hours).

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. Prerequisite: ED C 801, 810, 814, 850 or permission of instructor. (600 clock hours)

IV. Elective (three semester hours)
Under advisement, elective must be approved by program faculty.

Testing Requirements: Passing the departmental written comprehensive examination is a requirement for the degree. The student must have completed a minimum of 33 semester hours in the program and have the advisor’s permission to take the comprehensive examination. In addition, the guidance section of the National Teacher’s Exam (PRAXIS) must be passed and on record in the student’s file before certification verification will be sent to any State Department of Education.

ED F 701: Human Growth and Development, 3 cr. (3 and 0)
Theory and research in human development and its impact on the teaching/learning process. Prerequisite: ED 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 302 or equivalent; classroom teaching experience recommended.

ED F 778: Experimental and Nonexperimental Research Methods in Education I, 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 808 recommended.

II. Area of Specialization (27 semester hours)

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 810: Theories and Techniques of Counseling, 3 cr. (3 and 0)  
Counseling theories and techniques.  
Prerequisite: ED C 801 and 802 or permission of instructor.

ED C 811: Multicultural Counseling, 3 cr. (3 and 0)  
Responsibility of counselors to all people regardless of race, sex, gender, socioeconomic status, subculture, etc.; content and theory related to counseling multicultural individuals/groups.

ED C 812: 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 813: Appraisal Procedures, 3 cr. (2 and 2)  
Experience in gathering, interpreting and utilizing data as it relates to the individual; especially significant to counselors.  
Prerequisite: ED F 808 or permission of instructor.

ED C 814: Development of Counseling Skills, 3 cr. (3 and 0)  
On-campus experience to help counselors develop communication skills through role-playing activities, audio and videotaping, interviewing, lecture and discussion.  
Prerequisite or Corequisite: ED C 810.

ED C 815: Group Counseling, 3 cr. (3 and 0)  
Experience as a member of a group to aid the student in understanding group dynamics and the role of a group member as a participant and facilitator; emphasis is on small group participation, communication skills and self-understanding.  
Prerequisite: Permission of instructor.

ED C 816: 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 820: The School Counselor as Consultant, 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 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. (100 clock hours)

ED C 833: Secondary School Counseling Practicum II, 3 cr. (1 and 6)  
Additional field experiences in counseling, consulting and coordinating services for the secondary school student.  
Prerequisites: ED C 810, 814, 832 and 30 hours completed in the program. (600 clock hours)

IV. Elective (three semester hours)  
Under advisement, elective must be approved by program faculty.

Testing Requirements: Passing the departmental written comprehensive examination is a requirement for the degree. The student must have completed a minimum of 33 semester hours in the program and have the advisor's permission to take the comprehensive examination. In addition, the guidance section of the National Teacher's Exam (PRAXIS) must be passed and on record in the student's file before certification verification will be sent to any State Department of Education.

M.Ed., Student Affairs Practice in Higher Education, Emphasis  
Students completing the M.Ed. program in Counseling with an emphasis in Student Affairs Practice in Higher Education will demonstrate: ability to effectively work with faculty, students, administrators and other members of the academic community; preparation for employment in higher education settings in a variety of roles; ability to act as consultants throughout the higher education setting; understanding and skills related to counseling and developmental needs at the post-secondary level; a high degree of self-understanding; ability to effectively communicate with all cultural groups; a high degree of sensitivity and acceptance of diversity in thought and action; an awareness of the responsibilities of student affairs practitioners to the developmental needs and maintenance of quality experiences for students, faculty members, administrators and staff; and ethical practice.

Student Affairs Practice in Higher Education Specialty Area (48 semester hours)

I. Area of Specialization (33 semester hours)

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 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 810: Theories and Techniques of Counseling, 3 cr. (3 and 0)  
Counseling theories and techniques.  
Prerequisite: ED C 801 and 802 or permission of instructor.

ED C 811: Multicultural Counseling, 3 cr. (3 and 0)  
Responsibility of counselors to all people regardless of race, sex, gender, socioeconomic status, subculture, etc.; content and theory related to counseling multicultural individuals/groups.

ED C 812: 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 814: Development of Counseling Skills, 3 cr. (3 and 0)  
On-campus experience to help counselors develop communication skills through role-playing activities, audio and videotaping, interviewing, lecture and discussion.  
Prerequisite or Corequisite: ED C 810.

ED C 815: Group Counseling, 3 cr. (3 and 0)  
Experience as a member of a group to aid the student in understanding group dynamics and the role of a group member as a participant and facilitator; emphasis is on small group participation, communication skills and self-understanding.  
Prerequisite: Permission of instructor.

ED C 816: 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 820: The School Counselor as Consultant, 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 832: Secondary School Counseling Practicum, 3 cr. (1 and 6)  
Supervised field experience in counseling and other services in a secondary
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 departments. Prerequisites: ED C 803, 804.

ED C 810: Theories and Techniques of Counseling, 3 cr. (3 and 0)
Counseling theories and techniques. Prerequisite: ED C 801 and 802 or permission of instructor.

ED C 811: Multicultural Counseling, 3 cr. (3 and 0)
Responsibility of counselors to all people regardless of race, sex, gender, socioeconomic status, subculture, etc.; content and theory related to counseling multicultural individuals/groups.

ED C 812: 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 813: Appraisal Procedures, 3 cr. (2 and 2)
Experience in gathering, interpreting and utilizing data as it relates to the individual; especially significant to counselors. Prerequisite: ED F 808 or permission of instructor.

ED C 814: Development of Counseling Skills, 3 cr. (3 and 0)
On-campus experience to help counselors develop communication skills through role-playing activities, audio and videotaping, interviewing, lecture and discussion. Prerequisite or Corequisite: ED C 810.

ED C 815: Group Counseling, 3 cr. (3 and 0)
Experience as a member of a group to aid the student in understanding group dynamics and the role of a group member as a participant and facilitator; emphasis is on small group participation, communication skills and self-understanding. Prerequisite: Permission of instructor.

ED C 816: 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 820: The School Counselor as Consultant, 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 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; clinical or counseling. 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. Prerequisite: 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. Prerequisite: 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 the 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 15)
Supervised field experiences in counseling and other services in a community agency setting. Prerequisite: ED C 810, 814 or permission of instructor.

ED C 837: 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 838: 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 846: Community Counseling Internship, 1-6 cr. (1 and 1-6)
Students apply previous knowledge of counseling theory and techniques in a supervised field experience to professional mental health counseling settings. Prerequisites: ED F 701, ED C 805, 810, 813, 814, 815, 836 and 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.

Curriculum and Instruction

Antonis Katsiyannis, Coordinator, Graduate Programs

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<tr>
<th>Major</th>
<th>Degrees</th>
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<tr>
<td>Curriculum and Instruction</td>
<td>Ph.D.</td>
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The Doctor of Philosophy degree in curriculum and instruction is a research degree designed to prepare the student to become a scholar who can discover, integrate and apply knowledge, as well as communicate and disseminate it. The intent of the program is to prepare the student to make a significant original contribution to knowledge in a specialized field. The program prepares students in one of the following specialty concentrations: elementary education, English education, mathematics education, science education, social studies education, reading education or special education. These areas provide a general structure of course work selections and research emphases. However, students are encouraged to work with faculty to design programs uniquely fitted to their areas of interest.

The program of study for the degree is determined by the student's advisory committee. Every doctoral student must satisfy all requirements of the Graduate School as well as requirements in course work, internships, the comprehensive exam, the dissertation proposal and oral defense of the dissertation as directed by the student's advisory committee. Doctoral students in curriculum and instruction must maintain a B average in all graduate work. The degree usually requires a minimum of 70 semester hours beyond the master's degree selected from the areas prescribed by the requirements of the Ph.D. in Curriculum and Instruction. Listed below are the guidelines or normal expectations for a student receiving the Ph.D degree. However, the final determination of the course of study is made by the advisory committee.

Graduate courses designated for professional development are not eligible to be used toward a graduate degree. A minimum of three to six hours of internship is required as part of each specialty area. An internship of sufficient time and quality of experiences to warrant three to six semester hours of graduate credit must be planned and executed to the satisfaction of the student's advisory committee.

Specially areas require from six to 18 semester hours in courses outside the School of Education. Approved course work outside the school is intended to provide an area of concentration within the specialty area and/or exposure to disciplines outside the School of Education.

Admission Requirements: Complete application package to the Graduate School should include proof of major's degree; GPA of 3.5 on a 4.0 scale; a GRE composite score of 1450 (a minimum of 500 on the verbal section); relevant professional experiences; and an interview.

Students whose native language is not English must take the Test of English as a Foreign Language (TOEFL). Preference is given to those applicants who score a minimum of 575.

Core Requirements Goals: The student will: be able to critically analyze social, historical, psychological, personal and policy factors in the development and current practices of curriculum and instruction; acquire an understanding of the research processes including practical design, analysis and reporting; understand how to use historical, correlational, descriptive and experimental methods within research; be able to analyze critically and evaluate research reports; and be able to prepare scholarly, research-based reports and presentations.

1. Program Core Courses: Students must complete the following core courses totaling 34 hours.

1. The following 12 hours are required:

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 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)
Seminar in the application of learning theory to instructional practice emphasizing instructional strategies in the classroom. Prerequisite: ED 702.

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 ADA- and legal issues in 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.

2. Six hours chosen from the following courses:

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 L 950: Educational Policy Studies, 3 cr. (3 and 0)
Critical analysis of the sources and nature of educational policy and how policy
EX area Ph.D., the academic areas taught in the elementary

Emphasis in different areas elementary

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, correlation and non-parametric procedures. Prerequisite: Permission of instructor.

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 894 (ED F 894) (ED SP 894): Directed Research, 1-3 cr. (1-3 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.

II. Specialty Area: 27-30 hours; specialty area courses vary according to the area

III. Dissertation: 18 hours

ED 991 (ED F 991) (ED SP 991): Doctoral Dissertation Research, credit to be arranged

Ph.D., Elementary Education Emphasis

Students completing the Ph.D. program in curriculum and instruction with an emphasis in elementary education will demonstrate: 1) a research knowledge base of one or more of the academic areas taught in the elementary school with an understanding of how the different areas relate to the learning and instructional needs of all students including design, implementation and evaluation of curriculum; effective instructional methods; and current issues and trends affecting teaching and/or learning and 2) competency in basic and applied research and evaluation related to the elementary school such as curriculum, instruction and ancillary programs.

Elementary Specialty Area (30 hours with nine required hours)

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 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 adviser.

Selected Courses: 21 hours of course work approved by the doctoral committee, with at least six hours outside the School of Education.

Ph.D., Reading Education Emphasis

Students completing the Ph.D. program in curriculum and instruction with an emphasis in reading will demonstrate: 1) research knowledge base in the field of reading with an understanding of the relations to instructional needs of all students including design, implementation and evaluation of curriculum; effective instructional methods; and current issues and trends affecting teaching and/or learning and 2) competency in basic and applied research and evaluation related to the field of reading such as curriculum, instruction, assessment and ancillary programs.

Reading Education Specialty Area (30 hours)

A. Reading Education: 18 hours; six from the following:

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 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.

12 hours from the following:

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 Leader 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 Leader program. Corequisites: ED 755 and 855.

ED 854: Reading Recovery Theory I, 3 cr. (3 and 0)

First in 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 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 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 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 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.

B. Six hours from the following:

PSYCH 833: Advanced 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.

ENGL 700: Children's Literature for Teachers, 3 cr. (3 and 0)
Literature for preschool through junior high.

C. Internship - six required hours

D. Dissertation - 18 hours

Ph.D., Secondary Education Emphasis
(English, mathematics, science and social studies education)

The Ph.D. program in curriculum and instruction with an emphasis in English language, mathematics, natural sciences or social studies has the following five possible professional market niches. The student's program for each niche would contain appropriate study in both the subject area and niche to provide the necessary skills to be a productive professional. These five niches are (1) an English language, mathematics, science or social studies teacher educator in higher education, (2) a subject-specific curriculum coordinator or curriculum supervisor in a medium to large school district, state department of education or similar work for the federal government, (3) a teacher of English language, mathematics, science or social studies in a small four-year or community/technical college, (4) a curriculum developer of secondary English, mathematics, science or social studies or (5) an educator of programs in English language, mathematics, science or social studies in commerce and industry.

English Education Goals: Students completing the Ph.D. program in curriculum and instruction with an emphasis in secondary education-English will demonstrate a research knowledge base that includes current research in the areas of teaching composition, literacy response, language development, developments in English language, multimedia applications for the English classroom, within a literary canon that celebrates diversity and competency in basic and applied research and evaluation related to English education.

Mathematics Education Goals: The Ph.D. program in curriculum and instruction with an emphasis area in mathematics education will provide students with instruction and understanding in the mathematics curriculum—what is taught, the process of instruction, how mathematics is taught and assessed, the mathematical knowledge of the teacher—so that students may fulfill a variety of professional responsibilities. In addition, students will acquire the skills necessary to read, interpret, utilize and conduct research in mathematics education in order to expand the research knowledge base and allow students to apply knowledge to specific professional responsibilities.

Science Education Goals: Students completing the Ph.D. program in curriculum and instruction with an emphasis in science education will demonstrate an understanding of the research knowledge base in science education of how science process and content are most effectively learned, the components of state-of-the-art curriculum models which are most conducive and the utilization of the most effective research methodologies designed to expand the theory base.

Social Studies Education Goals: Students completing the Ph.D. program in curriculum and instruction with an emphasis in social studies education will develop a knowledge base in current social studies issues, research and classroom applications and be able to select and pursue appropriate research topics in social studies.

Secondary Education Specialty Area (30 hours)

A. Concentration: Advanced course work in a discipline or related areas: 18 hours

B. Internship: three to six hours

C. Advanced Studies in the Teaching of English, Mathematics, Science, or Social Studies: three hours from the appropriate area.

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-master's 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 science teaching theory and practice as shown by current research literature; emphasis on laboratory, inquiry and other student-centered teaching strategies; techniques in science curriculum development; issues in science teaching; science teaching leadership skills. 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.

D. Current Literature in Education - three hours from the appropriate area.

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.

Ph.D., Special Education Emphasis

Special Education Goals: Students completing the Ph.D. program in curriculum and instruction with an emphasis in special education will 1) demonstrate a research knowledge base of handicapping and at-risk characteristics integrated with an understanding of how these characteristics relate to the learning and instructional needs of individuals in the delivery of effective curricular and instructional, functional interventions; philosophical and social contexts of special and regular education; and legal and organizational context of special and regular education and 2) demonstrate competency in basic and applied research and evaluation, emphasizing special methodological concerns and evaluation of services with individuals with disabilities and at-risk characteristics.

Special Education Specialty Area (27 hours)

A. Special Education Courses: 15 hours as follows:

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 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 776 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, 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.

B. Courses outside the School of Education: six hours

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 765 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 754 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 Leader 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 Leader program. Corequisites: ED 754 and 854.

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-master's 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 science teaching theory and practice as shown by current research literature; emphasis on laboratory, inquiry and other student-centered teaching strategies; techniques in science curriculum development; issues in science teaching; science teaching leadership skills. 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; curricular 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 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 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 EDF 878

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)
Seminar in the application of learning theory 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 0)
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 adviser.

ED 991 (ED F 991) (ED SP 991): Doctoral Dissertation Research, credit to be arranged

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 teaching, 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; additional considerations for utilization of 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 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 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, comprehensive education, inclusion; strategies to minimize litigation; and trends in special education. Prerequisite: ED SP 402/602 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 726 and ED SP 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.

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.

EX ST 801: Statistical Methods I, 4 cr. (3 and 3) F, S, SS  
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.

PSYCH 833: Advanced 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.

ED F 808: Educational Tests and Measurements, 3 cr. (3 and 0)  
Construction, use and interpretation of subjective and standard tests; measurement applications.

II. Curriculum Development and Teaching Methods: six semester hours total

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 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.

IV. Specialized Content: 18 semester hours total: three hours from A, three hours from B and 12 hours from C

A. ED 762 Reading Diagnosis and Remediation

B. ED SP 820 Language Arts for the Exceptional Child

C. Option 1: Elementary - Six to nine hours of electives related to the specific content/subject matter taught in the elementary school and three to six hours of electives related to classroom practices, teaching methods and instructional techniques.

Option 2: Mathematics and Science - 12 hours of electives related to specific mathematics and science content taught in the elementary school.

Option 3: Language Arts - 12 hours of electives related to specific language arts content taught in the elementary school.

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 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 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 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 800: Philosophy, Schooling and Educational Policy, 3 cr. (3 and 0)  
Development of contemporary educational theory and its impact on current schooling practices and educational policy development.

ED F 701: Human Growth and Development, 3 cr. (3 and 0)  
Theory and research in human development and its impact on the teaching/learning process. **Prerequisites:** ED 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 motivation, class climate, class management and learning theory. **Prerequisite:** ED 302 or equivalent; classroom teaching experience recommended.

ED F 779: Experimental and Nonexperimental Research Methods in Education I, 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 808 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 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 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 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 789: 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 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 863: 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 F 702: Advanced Educational Psychology, 3 cr. (3 and 0)  
Educational applications of research and theory on motivation, class climate, class management and learning theory. **Prerequisite:** ED 302 or equivalent; classroom teaching experience recommended.

*If this course was completed at the undergraduate level, a substitution may be made with permission of the adviser.

Consult suggested courses for additional expertise in reading/language arts as listed below.
ED F 808: Educational Tests and Measurements, 3 cr. (3 and 0)
Construction, use and interpretation of subjective and standard tests; measurement applications.

Plus nine hours in additional reading/language arts course work. Suggested courses for additional expertise in reading/language arts:

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: ED 759 or equivalent.

ED 768: 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 generalizable instructional procedures. Prerequisite: ED 761 or equivalent.

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 classroom situations. 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 785: 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. Participant implements content studied in ED 750, which is taken concurrently. Prerequisite: Permission of instructor. Corequisite: ED 750.

ED 786: 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 787: Reading Recovery Teacher Practicum III, 3 cr. (0 and 9)
Teaching experience and practice in implementing and teaching in a Reading Recovery Program. Participants implement content studied in ED 752, which is taken concurrently. Prerequisites: Admission into the Clemson University Reading Recovery Program and ED 750 and 752. Corequisite: ED 751.

ED 790: 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 791: 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 792: 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.

Plan II. Reading Recovery Teacher, Reading Teacher and Reading Consultant

Ened 751: Reading Recovery Teacher II, 3 cr. (3 and 0)
Second in a two-course sequence designed to prepare teachers to implement and teach a Reading Recovery Program; issues related to reading theory and instructional processes; program implementation and evaluation. Prerequisite: Permission of instructor. Corequisite: ED 752.

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. Participant implements 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.

*If this course was completed at the undergraduate level, a substitution may be made with permission of the adviser.
Consult suggested courses for additional expertise in reading/language arts as listed above.
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 abstract resources and make appropriate literature selections for the teaching of reading. Prerequisite: Admission to the graduate program.

ED 780: An Integrated Approach to Reading and Writing Instruction, 3 hr. (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: Admission to the graduate program.

ED 795: Children’s Literature for Teachers, 3 cr. (3 and 0)
Literature for preschool through junior high.

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 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 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. Prerequisite: 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 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 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 863: 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 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 302 or equivalent; classroom teaching experience recommended.

ED F 808: Educational Tests and Measurements, 3 cr. (3 and 0)
Construction, use and interpretation of subjective and standard tests; measurement applications.

One (1) of the following educational leadership courses:

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 720: School Personnel Administration, 3 cr. (3 and 0)
School personnel selection, practices and problems. Prerequisites: ED L 700 and 705.

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.

One (1) of the following counseling courses:

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 811: Multicultural Counseling, 3 cr. (3 and 0)
Responsibility of counselors to all people regardless of race, sex, gender, socioeconomic status, subculture, etc.; content and theory related to counseling multicultural individuals/groups.

ED C 812: Career Counseling, 3 cr. (3 and 0)
Gathering, interpreting and utilizing educational, social and occupational information; techniques used in placement, survey and follow-up.

Suggested courses as substitutions:

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.

*If this course was completed at the undergraduate level, a substitution may be made with permission of advisor.
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 generalizable instructional procedures. Prerequisite: ED 761 or equivalent.

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 classroom situations. 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 761 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 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 863: Practicum in Reading, 3 cr. (2 and 2)
Supervised practicum emphasizing diagnostic and remedial work with readers in public schools. Prerequisite: ED 762 and permission of instructor.

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 302 or equivalent; classroom teaching experience recommended.

ED F 808: Educational Tests and Measurements, 3 cr. (3 and 0)
Construction, use and interpretation of subjective and standard tests; measurement applications.

Suggested courses as substitutions:

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 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.

ENGL 700: Children's Literature for Teachers, 3 cr. (3 and 0)
Literature for preschool through junior high.

Plan IV: Early Literacy Emphasis: Reading Teacher

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 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.

ENGL 700: Children's Literature for Teachers, 3 cr. (3 and 0)
Literature for preschool through junior high.

The purpose of an M.Ed. degree in secondary education is to assist secondary teachers in increasing competency in both subject content and instruction. Therefore, the program has practical and theoretical work in education as well as appropriate content in the natural sciences.

The student's adviser will depend upon the content specialty area. They are: English as a second language, Dr. Bea Bailey; mathematics, Dr. Bob Horton; natural sciences, Dr. Bill Leonard; and social studies, Dr. Sam Warner. Before enrolling for any graduate course, the student shall arrange a conference with the major adviser. Courses taken prior to this conference may or may not be acceptable for the degree. The advisory committee will consist of the major adviser, a faculty member chosen from the appropriate content teaching area department from whom the student has taken course work and a third member at-large (typically one from whom courses are taken). Upon successful completion of the examination, the committee will recommend that the degree be granted. The examination will be written and arranged at a specified time each semester.

The student is advised to observe deadlines for filing the GS-2 (program of study), for filing the GS-4 (application for diploma and graduation) and for having the adviser file the
GS-7 (completion of exit exam). In most cases, signatures of the adviser, the advisory committee, the department head and the dean are required before sending these forms to the Graduate School for final approval. The GS-2 is to be completed about halfway through the course of study and no later than a full semester prior to graduation. The GS-4 must be submitted by a full semester prior to the anticipated date of graduation. The GS-7 must be completed by the adviser, signed by each member of the committee and submitted by the middle of the semester of anticipated graduation. The specific dates for each of these forms are given in the Graduate Bulletin and refer to those times at which the completed forms are to be received by the Graduate School.

Admission Requirements: Complete application package to the Graduate School who requires a minimum grade point ratio of 2.5 by the State Department of Education; a minimum of fifteen (15) semester credits; a representative from the content department; and a letter of recommendation from the Graduate School, the department head and the dean must be submitted by a representative from the content department; and a representative from the content department.

Degree Requirements: This degree requires a minimum of thirty-six (36) semester hours in graduate courses with a GPR of at least 3.0, of which at least eighteen (18) hours must include at least three (3) credits in any higher numbered courses; a minimum of fifteen (15) semester hours in graduate courses in professional education, or substitute courses approved by the major adviser in the College of Education. Three to six of these hours may apply toward a thesis; a minimum of eighteen (18) hours of graduate courses in content areas or substitute courses approved by the major adviser in the College of Education, the Graduate School, the Department of Elementary and Secondary Education, and the appropriate teaching area; and all course work to be credited must have been enrolled in and completed within six calendar years prior to the date on which the degree is to be awarded. This includes at least three (3) credit hours of graduate work that may be transferred from another institution.

I. Required Education Courses (15 - 18 hours)

- Foundations Requirement (three hours); select from ED F 701 Human Growth and Development (3) or ED F 702 Advanced Educational Psychology (3).

ED F 701: Human Growth and Development, 3 cr. (3 and 0)
Theory and research in human development and its impact on 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. Prerequisites: ED F 302 or equivalent; classroom teaching experience recommended.

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 798*: Teaching Secondary School Reading, 3 cr. (3 and 0)
Methods and materials for secondary reading programs—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 F 778: Experimental and Nonexperimental Research Methods in Education I, 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 808 recommended.

ED F 808: Educational Tests and Measurements, 3 cr. (3 and 0)
Course covers construction, use and interpretation of subjective and standard tests; measurement applications.

II. Content Courses

A minimum of 18 hours of content courses at the 600, 700 or 800 level will be selected with the approval of the adviser. These should focus in one of four subject specialty areas: English language, mathematics, natural sciences or social studies.

III. Electives (three to six hours). These may be in education, the sciences or other as approved by the major adviser. Some appropriate courses are:

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 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 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; designed for 12-25 elementary, middle school, high school and adult education teachers. Prerequisite: Teaching certification.

ED 782: Literacy Across the Curriculum, 3 cr. (3 and 0)
Enables classroom teachers to use the theoretical basis 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 F 761 or equivalent, ED F 781 and admission to graduate school.

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.

*If this course was completed at the undergraduate level, a substitution may be made with permission of advisor.
The Master's of Education degree in special education is designed to ensure that students are knowledgeable of legal and policy issues in special education, assessment, characteristics and instruction of individuals with disabilities. The degree program in special education prepares students in one of the following specialty concentrations: emotional/behavioral disorders, learning disabilities or mental retardation. The program is approved by the Council for Exceptional Children (CEC) and follows guidelines prescribed by CEC. Successful graduates will apply knowledge and skills that are appropriate for instructing individuals with mild disabilities in a variety of settings. The graduate preparation in special education enables students to understand and critically evaluate the literature in the field, recognize and evaluate current issues and problems in special education, and identify potential solutions for these problems.

Students follow the approved program of study for the degree. All exceptions to the program of study must be approved by the students' advisory committees. All graduate students must satisfy requirements of the Graduate School, complete the approved course of study for the degree, maintain a B average in all graduate work, and pass the comprehensive exam. The degree requires 36 semester hours. Listed below are the guidelines for completing the M.Ed. degree in special education.

Admission Requirements: Complete application package to the Graduate School should include: a bachelor's degree; a valid teaching certificate; letters of recommendation; a GPA of 3.0 on a 4.0 scale; and an acceptable GRE score.

Applications for admission to the M.Ed. in special education are processed through the Graduate School, E-108 Martin Hall, Clemson University, Clemson, South Carolina 29634-5120. The Graduate School forwards official transcripts of all previous credits, three recommendations, and a complete application for admission to the department.

Core Requirements Goals: The student will: identify important legal and policy issues in special education; demonstrate knowledge of the research processes within the field of special education including practical design, implementation, analysis and knowledge of specific characteristics of individuals with disabilities; and implement research-validated interventions for students with disabilities.

Program Core Courses: 24 semester hours

ED F 778: Experimental and Nonexperimental Research Methods in Education I. 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 608 recommended.

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 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 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; research requirements, 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)
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 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.

South Carolina Certification Area: (nine hours)

The student must complete one of the following sequences for an M.Ed. in special education at Clemson University. To be eligible for a South Carolina endorsement in Emotional Disabilities, Learning Disabilities and/or Mental Disabilities, one must complete the corresponding course sequence(s) and NTE Specialty Area Examination.

I. Emotional Disorders Certification

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 674: Educational Procedures for Children with Emotional Disorders, 3 cr. (3 and 0)
Procedures for teaching students with emotional disorders; curriculum and instructional modifications, program planning, facility adaptation, behavior controls, 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)
Educational evaluation and instructional procedures to improve outcomes for individuals with learning disabilities. Prerequisites: ED F 302, ED SP 402 and PSYCH 201 or permission of instructor.

ED SP 678: Practicum in Emotional Disorders, 3 cr. (2 and 3)
Practical experience in teaching students with emotional disorders under the supervision of college faculty and local teachers. Prerequisites: ED SP 402, 469, 474, admission to the professional program; or permission of instructor.

II. Learning Disabilities Certification

*This course is required for South Carolina certification in emotional disabilities and should be included in the program of studies in three hours of electives.
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 675: Educational Procedures for Individuals with Learning Disabilities, 3 cr. (3 and 0)
Educational evaluation and instructional procedures to improve outcomes for individuals with learning disabilities. Prerequisites: ED F 302, ED SP 402 and PSYCH 201; or permission of instructor.

ED SP 676: Practicum in Learning Disabilities, 3 cr. (2 and 3)
Practical experience in teaching individuals with learning disabilities under the supervision of college faculty and local teachers. Prerequisite: ED SP 402, 470, 475, admission to the professional program; or permission of instructor.

III. Mental Retardation Certification

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. Prerequisites: Admission to the professional program or permission of instructor for graduate credit.

ED SP 679: Practicum in Mental Retardation, 3 cr. (2 and 3)
Experience in teaching individuals with mental retardation under the supervision of college faculty and local teachers. Prerequisites: ED SP 402, 472, 473, admission to the professional program; or permission of instructor.

Electives: (three hours)
For elementary emphasis ED SP 822 is recommended. For secondary emphasis ED SP 825 is recommended.

Students must declare degree-seeking status in the Graduate School prior to the completion of 12 semester hours toward an M.Ed. In addition to the required course work, certification sequence and electives all candidates for a M.Ed. in special education are required to pass a comprehensive examination. Comprehensive examinations are administered following the completion of an approved program of study.

Depending on previous course work, elective courses may be substituted by the student's advisory committee.

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 six 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)
Procedures for teaching students with emotional disorders: curriculum and instructional modifications, program planning, facility adaptation, behavior control, communication 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)
Educational evaluation and instructional procedures to improve outcomes for individuals with learning disabilities. Prerequisites: ED F 302, ED SP 402 and PSYCH 201; or permission of instructor.

ED SP 676: Practicum in Learning Disabilities, 3 cr. (2 and 3)
Practical experience in teaching individuals with learning disabilities under the supervision of college faculty and local teachers. Prerequisites: 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 under the supervision of college faculty and local teachers. Prerequisites: 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)
Experience in teaching individuals with mental retardation under the supervision of college faculty and local teachers. Prerequisites: ED SP 402, 469, 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 806 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 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 adviser.

ED SP 991 (ED F 991) (ED 991): Doctoral Dissertation Research, credit to be arranged

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Technology and Human Resource Development

Gerald G. Lovedahl, Area Coordinator

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<tr>
<td>Industrial Education</td>
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The human resource field is a specialized blend of education, counseling, psychology, management and sociology. The Master's degree in human resource development (MHRD) is designed to prepare industrial training directors, educational specialists, training coordinators and personnel for HRD occupations in business, industry and the public sector.

HRD specialists commonly provide training related to the areas of technical and interpersonal skills, management and motivation. 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 control, information services 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 MHRD program are reviewed on undergraduate course work, academic performance and employment experience. The program requires 36 hours including 15 hours in core human resource development courses, six hours in research methods and 15 elective hours in course work appropriate to individual career objectives, such as personnel management, organizational development, career counseling, compensation management, etc.

This program is 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.
HRD 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.

HRD 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: HRD 830 or permission of instructor.

HRD 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. Prerequisite: HRD 830 and 845 or permission of instructor.

HRD 849: Evaluation of Training and Development/HRD 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: HRD 830, 845, 847, 860 and IN ED 889 or permission of instructor.

HRD 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 materials development procedures that are applied across human resource development (HRD) programs. Prerequisites: HRD 830 and 845.

HRD 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 special 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 adviser and satisfactory completion of 12 hours of graduate H RD courses and IN ED 889.

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. Application (six to nine credit hours)

HRD 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. Prerequisite: Employment or ready access to an employer and place of employment; THRD 468/668 is desirable.

HRD 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: HRD 830 or permission of instructor.

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 865: American Industries, 3 cr. (3 and 0)
Concepts and principles of American industry and technology. Industrial plant visits supplemented by study of industrial organization, economics, management, production and products.

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 adviser and completion of nine hours in the major.

THRD 610 (G C 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 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.

VT ED 876: College Teaching, 3 cr. (3 and 0)
Instructional practic, curriculum; techniques of organizing and planning learning experiences; analysis of teaching strategies and systems. Cognate Theory (six to nine credit hours)

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 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.
ECON 816 (AP EC 816): Labor Economics, 3 cr. (3 and 0) Wage and employment theory; labor markets; labor history; current problems in labor and manpower economics.

ECON 824 (AP EC 824): Organization of Industry, 3 cr. (3 and 0) The structure of markets and firms, forces that determine the size of firms and the boundaries of markets; the behavior of firms, both singly and in concert, to exploit market positions.

ED C 810: Theories and Techniques of Counseling, 3 cr. (3 and 0) Counseling theories and techniques. Prerequisite: ED C 801 and 902 or permission of instructor.

ED C 811: Multicultural Counseling, 3 cr. (3 and 0) Responsibility of counselors to all people regardless of race, sex, gender, socio-economic status, subculture, etc.; content and theory related to counseling multicultural individuals/groups.

ED C 812: 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 813: Appraisal Procedures, 3 cr. (2 and 2) Experience in gathering, interpreting and utilizing data as it relates to the individual, especially significant to counselors. Prerequisite: ED C 808 or permission of instructor.

ED C 815: Group Counseling, 3 cr. (3 and 0) Experience as a member of a group to aid the student in understanding group dynamics and the role of the group member as a participant and facilitator; emphasis is on small group participation, communication skills and self-understanding. Prerequisite: Permission of instructor.

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 F 808: Educational Tests and Measurements, 3 cr. (3 and 0) Construction, use and interpretation of subjective and standard tests; measurement applications.

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.

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 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 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 aesthetic and philosophical 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.

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; statistical computer analyses and interpretations including computer generated graphics. Prerequisite: MTHSC 206 or permission of instructor.

EX ST 801: Statistical Methods I, 4 cr. (3 and 3) F, S, SS 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, 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.

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 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 874 (M B A 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 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: MGT 803 or permission of instructor.

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.

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 659: Group Dynamics, 3 cr. (3 and 0) S
Current theory and research on small-group processes, group formulation and development, group structure, the dynamic forces within a group, leadership and group problem solving and decision making. Prerequisites: PSYCH 201 and one 300-level psychology course or permission of instructor.

PSYCH 860: Psychology of Training and Evaluation, 3 cr. (3 and 0) S
Evaluation issues such as criteria development, organizational assessment, process and outcome criteria along with instructional methodologies such as fairness in training, special populations, second careers, hard-core unemployment, and ethics of organizational and industrial change. Prerequisite: A course in industrial psychology, personnel psychology or equivalent.

PSYCH 862: Organizational Development, 3 cr. (3 and 0) S
Forms of organizational structure and basic theories of organizations; theories and techniques of organizational development and change; relationships between organizational design and technology. Prerequisite: A course in industrial/organizational psychology or equivalent.

PSYCH 863: Work Motivation and Satisfaction, 3 cr. (3 and 0) S
Explanations for absenteeism, productivity, job satisfaction and withdrawal, as well as their interrelations; methods of measuring attitudes and opinions and general theories of human motivation. Prerequisite: An industrial/organizational psychology course or equivalent.

SOC 803: Survey Designs for Applied Social Research, 4 cr. (3 and 2) 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 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.

Industrial Education
Gerald G. Lovedahl, Area Coordinator

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<th>Major</th>
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Master of Industrial Education (M.IND.
The Master of Industrial Education degree allows for specialization in three areas: industrial technology education, vocational/technical education and administration and supervision for the two-year college.

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 post-secondary 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.

All three of these concentrations require 30 semester hours of course work with a minimum 3.0 GPA and successful completion of an oral comprehensive examination prior to the awarding of the degree.

Admission Requirements: Complete application package to the Graduate School should include: a bachelor's degree from an approved college/university; departmental approval; industrial technology education applicants must hold or meet the minimum requirements for an industrial technology teacher's certificate; vocational/technical education applicants must hold or meet minimum requirements for a trade and industrial teacher's certificate, or show vocational or technical competence through training, work experience or proficiency test results; and 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.

INDUSTRIAL TECHNOLOGY EDUCATION CONCENTRATION

I. Foundations
ED F 701: Human Growth and Development, 3 cr. (3 and 0) S
Principles and research in human development and its impact on the teaching/learning process. Prerequisites: ED 334, 335, 336 or equivalent; classroom teaching experience.

ED F 702: Advanced Educational Psychology, 3 cr. (3 and 0) S
Educational applications of research and theory on objectives, motivation, class climate, class management and learning theory. Prerequisite: ED 302 or equivalent; classroom teaching experience recommended.

VT ED 810: Foundations of Vocational and Technical Education, 3 cr. (3 and 0) S
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 850: Programs, Concepts and Issues in Vocational and Technical Education, 3 cr. (3 and 0) S
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.

II. Organization and Administration
ED C 815: Group Counseling, 3 cr. (3 and 0) S
Experience as a member of a group to aid the student in understanding group dynamics and the role of a group member as a participant and facilitator; emphasis is on small group participation, communication skills and self-understanding. Prerequisite: Permission of instructor.

ED L 715: School and Community Relationships, 3 cr. (3 and 0) S
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 725: Legal Phases of School Administration, 3 cr. (3 and 0) S
Legal principles involved in school administration and in court actions. Prerequisites: ED L 700 and 710.

IN ED 846 (H R D 846): Applied Public Relations, 3 cr. (3 and 0) S
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 468/688** is desirable.

**THRD 668: 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.

**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.

**III. Curriculum and Instruction**

**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 F 808: Educational Tests and Measurements, 3 cr.**

(3 and 0)

Construction, use and interpretation of subjective and standard tests; measurement applications.

**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.

**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/curricular 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 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.

**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, transparency, and Persuasion and/or Powerpoint, and fully storyboarded, scripted, and edited digital as well as analog video.

**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.

**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.

**IV. Research**

**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 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 adviser 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 adviser and completion of IN ED 895.

**V. Technical Electives: (six credit minimum; see adviser for additional courses)**

**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.

**THRD 610 (G C 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 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 majors. **Prerequisite:** THRD 640 or permission of instructor.

* Denotes required courses.
THRD 650: Electronics for Educators, 3 cr. (1 and 6)
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 650 or equivalent.

THRD 682 (ED 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 680.

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.

Special Institute Courses may substitute for certain requirements in the Industrial Technology Education concentration. See your adviser for applications.

VOCATIONAL-TECHNICAL EDUCATION CONCENTRATION

I. Foundations
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.

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 846 (H R D 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 468/668 is desirable.

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.

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, philosophical and theoretical undercurrents; definition of broad parameters of the field.

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.

II. Curriculum and Educational Theory
ED C 812: 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 F 808: Educational Tests and Measurements, 3 cr. (3 and 0)
Construction, use and interpretation of subjective and standard tests; measurement applications.

IN ED 820: Recent Process Developments, 3 cr. (3 and 0)
Recent technological and sociological innovations, inventions, processes and products, and their impact on our industrial, labor, educational and social institutions.

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; rational 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 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.

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.

III. Research
EX ST 801: Statistical Methods I, 4 cr. (3 and 3) F, S, SS
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 nonparametric procedures. Prerequisite: 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 adviser 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 adviser and completion of IN ED 895.

IV. Technical Electives (see adviser)
Candidates preparing to teach technical subjects should select electives to enhance their individual competencies. In addition to regular classes, these strengths may be developed through enrollment in such experiences as THRD 692, which may be taken for one to six credits. The particular technical electives should be carefully planned by the student and adviser.

* Denotes required courses.
ADMINISTRATION AND SUPERVISION/TWO-YEAR COLLEGE CONCENTRATION

I. Organization and Administration

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 745: School Finance, 3 cr. (3 and 0)
School finance relative to programs, revenues and experience. Prerequisites: ED L 700 and 735.

ED L 805: Advanced Educational Leadership: Theory and Practice, 3 cr. (3 and 0)
Principles and theories of leadership as practiced in the institutional setting. Prerequisites: ED L 700, 715 and 730.

ED L 810: Introduction to School Building Planning, 3 cr. (2 and 2)
Planning of educational facilities from conception of need through utilization of facility. Prerequisite: ED L 700.

ED L 830: Business Management in Education, 3 cr. (2 and 3)
Fiscal management of individual schools and districts, including budgeting, purchasing and accounting for funds. Prerequisites: ED L 700, 725 and 745.

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.

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 for the local 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.

THRD 668: 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.

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 876: College Teaching, 3 cr. (3 and 0)
Instructional practices; curriculum; techniques of organizing and planning learning experiences; analysis of teaching strategies and systems.

III. Research (six credits required)

ED L 840: 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.

EX ST 801: Statistical Methods I, 4 cr. (3 and 3) F, SS
Role and application of statistics in research; estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, means square estimations, variance components analysis, simple and multiple linear regression and correlation, non-parametric procedures. Prerequisite: Permission of instructor.

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.
**Vocational/Technical Education**

Gerald G. Lovedahl, Area Coordinator

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<th>Major</th>
<th>Degree</th>
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<td>Vocational/Technical Education Ed.D.</td>
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**Doctor of Education degree in Vocational and Technical Education (VTED)**

The Doctor of Education degree in vocational and technical education (VTED) is designed to prepare graduates for leadership positions in the profession. Curricula are designed for vocational and technically-oriented personnel in colleges and universities, public schools, industry and vocationally-oriented agencies.

The program for the Doctor of Education (Ed.D) in VTED may involve all of the colleges of the University. Existing programs in other colleges will provide an opportunity for the acquisition of technical knowledge and skills from the broad spectrum represented in vocational and technical education and human resource development. Students will have considerable latitude in following their areas of interest because of the broad program offerings.

A minimum of 12 hours of course work is required outside the education area. It is anticipated that a number of students will desire additional courses to enhance their vocational and/or technical competencies in their professional fields of endeavor.

Arrangements for such a program are encouraged by the VTED departments/areas and have been agreed to by the various colleges of the University. Provision has been made for faculty members from other colleges to be named to the candidates’ advisory committees. The candidates will help create the candidates’ program by furnishing expertise in selecting meaningful sequences of courses in their respective schools and colleges.

Areas of specialization include: administration, guidance, curriculum and instruction, human resource development and teaching. These areas give a general structure to course work selections and research emphasis but are not prescriptive in nature.

**Admission Requirements:** Complete application packet to the Graduate School should include: a letter of application and a resume sent to G-01Tillman Hall, Clemson University; a master’s degree; a GPA of 3.5 on a 4.0 scale; a GRE composite score of 1450 (minimum of 450 on the verbal section) or a Miller’s Analogies Test (MAT) score of 50 or higher. Scores must be no older than five years, and from a single administration of the exam; completion of three years of successful experience in proposed field of professional study (may be waived for admission but must be met before applicant can become a candidate for the degree); students whose native language is not English must take the Test of English as a Foreign Language (TOEFL), preference being given to those applicants who score a minimum of 575; and an interview.

The application process is self-managed. The appropriate forms for requesting transcripts, recommendations, etc., are included in the application packet. These items are returned to the student in sealed envelopes, and then forwarded by the student to the Graduate School once all the items have been received. Do not open the transcripts or recommendations when they arrive. Send them to the graduate school, with the other items, unopened. Send the narrative letter and resume directly to Dr. G.G. Lovedahl. G-01 Tillman Hall, Clemson University, Clemson, SC 29634. Do not send them to the Graduate School. Once all of the items have been submitted and forwarded by the Graduate School to the department, the student’s file will be complete and ready for review by the VTED admissions committee. This committee meets twice each year, in November and April, and only completed files are considered.

**Degree Requirements:** The following minimum academic requirements must be completed by each student: a minimum of 80 semester hours of graduate credit beyond the Bachelor’s degree plus a dissertation (96 total hours); a maximum of 48 semester hours of transfer credit is allowed; a minimum of 14 semester hours of graduate credit in statistics and research; an internship approved by advisory committee members from other agencies; a minimum of 18 semester hours of graduate credit in candidate’s area of specialization or professional interest; no course work from the master’s degree may be used to satisfy this requirement, and must be approved by graduate committee; a minimum of 12 semester hours of graduate course work required from departments/areas other than Agricultural Education, Technology & Human Resource Development, Graphic Communications or any area in education; and a minimum of 18 semester hours of dissertation research.

**Core Requirements Goals:** The core of the program required of all students includes 12 semester hours of vocational/technical foundations and 14 to 15 hours of research and statistics. The following courses (or equivalents) are required of all students in meeting the degree requirements.

| I. Vocational/Technical Foundation |

**VT ED 810: Foundations of Vocational and Technical Education, 3 cr.**

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.

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<tr>
<th>VT ED 980: Internship in Vocational/Technical Education, 1-6 cr.</th>
<th>(0 and 3-18)</th>
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<tr>
<td>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. <strong>Prerequisite:</strong> Permission of the student’s major adviser.</td>
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* Denotes required courses.
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.

**II. Research and Statistics**

**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.

**EX ST 801: Statistical Methods I, 4 cr. (3 and 3) F, S, SS**
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 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 or PSYCH 810 (Research) or

**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.

**VT ED 882: Seminar, 1 cr. (1 and 0)**
Current issues and problems and proposed research projects. May be taken twice for credit.

**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.

Also required of all students, and designed to complement each student's professional goals, are the following:

**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 adviser.

**VT ED 991: Doctoral Dissertation Research, credit to be arranged**

### SCHOOL OF NURSING

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<th>Major</th>
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<td>Nursing</td>
<td>M.S.</td>
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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), nurse practitioner (NP) or nurse administration. The student may select one of the five study options. 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 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 and testing questions and theories about practice and research; processes of theoretical thinking and clinical thinking applied to health problems and needs of individuals and their families in the community; conceptual and theoretical models of contemporary practice and research.

**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). Selected study options are the 3 + 2 programs in conjunction with the School of Business Administration and the School of Education. The program is designed to provide graduates with the knowledge and skills needed for professional practice and for the development of nursing knowledge; ethics with human subjects; does not include clinical experiences in advanced assessments of clients of several ages. **Prerequisites or Corequisites:** NURS 801 and NURS 809.

**NURS 804: Knowledge Development in Advanced Nursing, 2 cr. (2 and 0)**
Nursing theories and theories relevant to advanced nursing practice; processes of theoretical thinking and clinical 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 prescribed for common or chronic illnesses; drug selection; adverse drug reactions; age-related changes 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 of 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. This 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 health 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 Practicum, 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 theories, 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 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 0)
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 restorative 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 synthesized and applied to the analysis of mental health/illness in older adulthood; roles and functions of advanced practice nurses in promoting the mental health of individuals and their families. Clinical practice is in the community. Prerequisites: NURS 801, 804, 805, 806, 807 and 809.

NURS 885: Informatics in Aging, 2 cr. (2 and 0)
Computer-based systems of information management of nursing geriatric environments; data needed for cost management of nursing resources and effective systems as tools useful to the management of geriatric assessment, health record systems and patient care.

NURS 889: Special Problems in Nursing, 1-6 cr. (1-6 and 0)
Problems selected to meet special and individualized interests of students. Up to six hours of NURS 889 may be taken as elective credit. Prerequisites: NURS 801, 804, 807 and permission of instructor.

NURS 911: Master's Thesis Research, credit to be arranged
Research activities related to thesis; minimum of six hours required. Prerequisites: NURS 802, 804 and 807.
The department offers a professional master's degree (M.P.R.T.M.), a Master of Science degree (M.S.) and a Doctor of Philosophy degree (Ph.D.). Flexibility permits individual development in professional interest areas such as therapeutic recreation, travel and tourism management, recreation resource management and interpretation, and administration of recreation, park or tourism systems. Each student's program is tailored to suit his or her personal and professional goals. Applicants from nonrecreation disciplines are required to develop background knowledge of recreation through undergraduate coursework. All applicants must submit GRE scores.

The Master of Parks, Recreation and Tourism Management should be selected by individuals who intend to enter or return to the workplace upon the completion of degree requirements. Applicants for the M.P.R.T.M. degree who document at least three years of relevant professional experience beyond a bachelor's degree in recreation and a 3.0 undergraduate GPA are not required to submit GRE scores for admission. Each candidate completes an independent project to meet degree requirements. A minimum of 36 hours of course work is required.

The Master of Science is a research degree with a research thesis requirement. This degree is designed for individuals planning to undertake doctoral study or seek employment 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 613: Therapeutic Recreation for Selected Populations, 3 cr. (2 and 0)
Therapeutic recreation services for the developmentally disabled or person 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 615: Methods in Reducing Risks for Middle School, 3 cr. (2 and 3)
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 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 mediated 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 643: Resorts in National and International Tourism, 3 cr. (3 and 0)
Case-study of a variety of resort types with respect to their development, organization, visitor characteristics and environmental consequences.

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 645: Conference/Convention Planning and Management, 3 cr. (3 and 0)
Problems of and solutions to conference and convention planning and management from both the sponsoring organization and facility manager's perspectives.

PRTM 646: 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 investi-
gation of a special problem to use
knowledge gained in formal courses,
provide experience and training in re-
search, and prepare for professional goals;
report of findings required. May be re-
peated with a maximum of three credit
hours applied toward graduation require-
ments. 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 re-
peated 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 rec-
reation as they are influenced by and
have influence on leisure and the chang-
ing 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. Stu-
dents gain understanding of how others
affect these and how they affect others
and become more effective professional
recreators, park administrators, supervi-
sors, 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 theo-
ries 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 environ-
mental influences on human behavior;
identification of theoretical perspectives
to explain behavior and to resolve prob-
lems 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 di-
ensions of the recreation experience in
a variety of environments and activi-
ties. Prerequisite: Graduate standing.

PRTM 812: Leisure Services for the
Elderly, 3 cr. (3 and 0)
The elderly and the role of leisure ser-
VICES in later life; needs of community-
based and institutionalized elderly; ser-
dvice delivery systems to meet these needs.

PRTM 815: Therapeutic Recreation and
Activity Therapy Administration,
3 cr. (3 and 0)
Service delivery structures; interdiscipli-
nary relationships; consultation methods;
in-service training; funding sources; ser-
dvice 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 map-
ning, spatial analysis and natural resource
inventory using remote sensing and
geographical information systems. Pre-
quisite: Permission of instructor.

PRTM 820: Recreation Resource Policy
Issues and Processes, 3 cr.
(3 and 0)
Outdoor recreation policy-formation struc-
tures 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 tech-
niques; planning process and associated
concerns such as market, facility, infra-
structure, environment, culture and eco-
nomics. Prerequisite: Graduate stand-
ing.

PRTM 843: Tourism Analysis, 3 cr.
(3 and 0)
Selected theories, methods, techniques,
practices and principles that govern tour-
ism 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 devel-
opment 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 prob-
lems in parks, recreation and tourism
not covered in other PRTM 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 re-
quired. May be taken for a maximum of
three credits per semester. May be re-
peated 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 semes-
ters. Graded on a pass/fail basis.

PRTM 991: Doctoral Dissertation
Research, credit to be arranged

Public Health Sciences

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<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>MHA 721</td>
<td>Health Care Delivery Systems</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>MHA 722</td>
<td>Health Behavior and Epidemiology</td>
<td>2 cr.</td>
<td>(2 and 0)</td>
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<tr>
<td>MHA 729</td>
<td>Health Care Finance</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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These are the core courses in the MHA program.

Clemson University and the Medical Uni-
versity of South Carolina jointly offer the Mas-
ter 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-behav-
ioral 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, deci-
sion-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 Gre-
enville 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.

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 organiza-
tions and general management and oper-
ations theory.

MHA 721: Health Care Delivery
Systems, 3 cr. (3 and 0) Development of the health services del-
ivery system in the United States.

MHA 722: Health Behavior and
Epidemiology, 2 cr. (2 and 0) Health behavior of a popula-
tion 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 BA 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; sampling theory and design; basic experimental designs and time series analysis. Prerequisite: Basic statistics.

M BA 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.

M BA 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 the 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: M BA 803 and a demonstrated proficiency in basic management.

M BA 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.

M BA 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.

M BA 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 MHA.

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 professional 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.

HRD 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.

MGT 818: Management Support Systems, 3 cr. (3 and 0)
Computer-based management support systems.

M BA 802: Managerial Economics, 3 cr. (3 and 0)
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: Economic principles and basic statistics.

M BA 813: Industrial Relations, 3 cr. (3 and 0)
N
Relation 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 is also examined.
M B A 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: M B A 808 or 858 or permission of instructor.

These are additional graduate courses offered within Public Health Sciences.

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.

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 of cultural norms, prevention and early intervention as it relates to obesity and eating disorders. Prerequisite: Junior standing in health science or permission of instructor.

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 problems 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 658: 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.

NURS 889: Special Problems in Nursing, 1-6 cr. (1-6 and 0)
Problems selected to meet special and individualized interests of students. Up to six hours of NURS 889 may be taken as elective credit. Prerequisites: NURS 801, 804, 807 and permission of instructor.

NURS 891: Master's Thesis Research, credit to be arranged
Research activities related to thesis; minimum of six hours required. Prerequisites: NURS 802, 804 and 807.
Graduate Interdisciplinary Programs

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Policy Studies • 190
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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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 of 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 821), 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 605), Advanced Painting (ART 607), Advanced Sculpture (ART 609), Advanced Printing (ART 611), Advanced Modeling Techniques in Computer Graphics (CP SC 805), Computer Animation (CP SC 806), Digital Image Processing (ECE 647), 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

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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 political economy 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 have the opportunity to concentrate 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, environmental policy, 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.
PO ST 810: Political Economy, 3 cr. (3 and 0)
An exploration of how public policy can be analyzed within a common framework that considers the objectives and constraints imposed on individuals in political and economic situations, the decision rules consistent with these objectives and constraints, and the likely outcomes of various policy objectives. **Prerequisite:** Admission to certificate or Ph.D. in policy studies or permission of instructor.

PO ST 822: Policy Analysis and Political Choice, 3 cr. (3 and 0)
Examines opportunities and constraints that exist in political systems; political feasibility and policy strategy assessment. Topics include role of power, ideas, organizational interaction, cognitive processes, interest groups, policy analysis, media and random opportunity in determining policy outcomes. **Prerequisite:** Admission to policy studies program or permission of instructor.

PO ST 842: Ethics and Public Policy, 3 cr. (3 and 0)
Explores the ethical dimensions of policy by examining moral and ethical issues raised by problem solving and decision making; evaluation procedures integrating ethical dimensions into policy assessment. Topics include model codes of ethics for public officials and exploration of comparable standards for privately employed policy professionals. **Prerequisite:** Admission to certificate or Ph.D. in policy studies or permission of instructor.

PO ST 843: Organization Theory and Public Management, 3 cr. (3 and 0)
Examines the theoretical and analytical foundations for understanding bureaucracies and leadership roles in public management; clarification of the distinctly "public" dimensions and challenges of management. Interdisciplinary in nature, the course draws on business and public administration, social psychology, economics, political science and sociology. **Prerequisite:** Admission to certificate or Ph.D. in policy studies or permission of instructor.

PO ST 851: Rural Sustainable Development: Evolution of Public Policy, 3 cr. (3 and 0)
Examines the formulation of current national and local public policies that impact rural community development; the constraints and opportunities they provide; interaction among government institutions, decision makers and interest groups; associated influence on rural sustainability. **Prerequisite:** Admission to certificate or Ph.D. in policy studies or permission of instructor.

PO ST 861: Space Policy, 3 cr. (3 and 0)
Space science technology, civilian and military government programs and private-sector activities; case studies of long-term space policy issues impacting remote sensing, communications and manned space stations; origins of programs and evolution of associated policy issues examined from a national and international perspective. **Prerequisite:** Admission to certificate or Ph.D. in policy studies or permission of instructor.

PO ST 893: Internship in Policy Analysis, 3 cr. (3 and 0)
Twelve-week supervised internship with an approved public or private entity focusing on policy analysis. Monthly reports by student and an agency are required. Graded on a pass/fail basis. **Prerequisite:** Two semesters of course work in policy program.

PO ST 904: Policy Analysis Seminar I, 1 cr. (1 and 0)
One-hour seminar module focusing on research methodology with readings and discussion. **Prerequisite:** Three semesters of course work in policy studies program.

PO ST 905: Policy Analysis Seminar II, 1 cr. (1 and 0)
Each module involves student research with articles prepared for a professional audience and presented as part of the seminar series. Ph.D. students will repeat this course for a total of two credits. **Prerequisite:** PO ST 904 and three semesters of course work in policy studies program.

PO ST 991: Doctoral Dissertation Research, 1-18 cr. (0 and 0)
Credit to be arranged.
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