

Graduate Announcements 2012-2013



NOTIFICATION OF RIGHTS UNDER THE FAMILY EDUCATIONAL RIGHTS AND PRIVACY ACT (FERPA)

The Family Educational Rights and Privacy Act (FERPA) affords students certain rights with respect to their education records. These rights include:

1. The right to inspect and review the student's education records within 45 days of the day the University receives a request for access.

A student should submit to the registrar, dean, head of the academic department, or other appropriate official, a written request that identifies the record(s) the student wishes 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, misleading, or otherwise in violation of the student's privacy rights under FERPA.

A student who wishes to ask the University to amend a record should write the University official responsible for the record, clearly identify the part of the record the student wants changed, and specify why it should be changed.

If the University decides not to amend the record as requested, the University will notify the student in writing of the decision and the student's right to a hearing regarding the request for amendment. Additional information regarding the hearing procedures will be provided to the student when notified of the 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 provide written consent before the University discloses personally identifiable information from the student's education records, except to the extent that FERPA authorizes disclosure without consent.

The University discloses education records without a student's prior written consent under the FERPA exception for disclosure to school officials with legitimate educational interests. A school official is a person employed by the University in an administrative, supervisory, academic or research, or support staff position (including law enforcement unit personnel and health staff); contractors, consultants, volunteers and other outside parties to whom the institution has outsourced institutional services or functions instead of using University employees or officials (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 school 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 or her professional responsibilities for the University.

Upon request, the University also 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, permanent address and telephone number, local address and telephone number, e-mail address, state of residence, date and place of birth, marital status, academic class, class schedule and class roster, name of advisor, major field of study, including the college, division, department or program in which the student is enrolled, participation in officially recognized activities and sports, weight and height of members of athletic teams, dates of attendance and graduation, degrees and honors and awards received including selection to a dean's list or honorary organization and the grade point average of students selected, and the most previous educational institution attended. Photographic, video, or electronic images of students taken and maintained by the University are also considered directory information.

Directory information may be disclosed by the University for any purpose, at its discretion. Any student wishing to exercise his/her right to refuse to permit the designation of any or all of the above categories as directory information must give written notification to the Registration Services Office (E-206 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 the 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, 400 Maryland Avenue, SW, Washington, DC 20202-5901.

GRADUATE SCHOOL

ENVIRONMENTAL TOXICOLOGY

Master of Science

Doctor of Philosophy

These programs are jointly administered with the College of Agriculture, Forestry and Life Science.

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. Emphases 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 administered jointly with the College of Engineering and Science.

Students with baccalaureate degrees 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/her professional goals.

Candidates for the MS degree must complete 30 hours of graduate credit, including six hours of research, and write a thesis. Candidates for the PhD 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.

POLICY STUDIES

Doctor of Philosophy

Certificate

Clemson University offers graduate studies leading to a PhD degree 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 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.

The program emphasizes 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. PhD students also select a concentration in Agricultural Policy, Environmental and Natural Resource Policy, Rural and Economic Development Policy, or Science and Technology. Flexibility is also achieved through enrichment, electives, leadership development courses, and the selection of a PhD dissertation topic. The program consists of a minimum of 63 credit hours beyond the bachelor's degree, of which up to 24 credits may be drawn from master's degree and other postgraduate work. There is no foreign language requirement for the PhD degree in Policy Studies.

The graduate program in Policy Studies also offers students enrolled in related master's and doctoral programs the opportunity to gain competence in and understanding of policy analysis. Depending on students' backgrounds and academic preparation, they may supplement their primary master's coursework 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 12 credit hours of coursework.

The faculty in Policy Studies encourages applications for the PhD program from recipients of a master's degree who wish to acquire policy research and analytical skills in economic development, agriculture, natural resource allocation, rural development, small town and community development, tourism development, environmental issues, land use, infrastructure, public finance, growth management, and science and technology. Master's-level students with similar interests are encouraged to enhance their graduate studies with a Certificate in Policy Studies.

The faculty encourages applications from students who have backgrounds that will facilitate an interdisciplinary course of study. In many cases, students may be admitted to full graduate status in the PhD program without prerequisites other than those required of all graduate students.

PUBLIC ADMINISTRATION

Master of Public Administration

The Master of Public Administration degree program requires 39-45 credit hours, depending on the student's background. Students lacking proficiency in American government are required to address the deficiency by taking a prerequisite in this area. 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 MPA

students must complete seven core courses (P ADM 702, 821, 822, 827, 829, 862, PO SC 841). In addition, one level of government course (P ADM 867, 868, or PO SC 860) and five electives must be completed. Finally, all students must demonstrate a proficient knowledge of the field of public administration by passing a comprehensive examination. Students may request to take P ADM 880 in lieu of the comprehensive examination.

Certificate in Public Management

Admission Requirements

Admission will be based on an assessment of the applicant's educational needs and career objectives. Applicants must hold a bachelor's degree and should have earned an overall 3.0 grade-point ratio in all undergraduate studies. Each applicant must also furnish a letter of recommendation, an application (available from the MPA program office), transcripts, statement of career objectives, and a résumé.

Students from any department or discipline may elect to complete the certificate program. Students who are already enrolled in a graduate degree program must obtain written approval from their graduate programs/advisors and the MPA Director. No prerequisites are required of these students.

In addition to the conditions above, international applicants are required to demonstrate that they satisfy the University's minimum English language proficiency requirements or equivalent.

Students currently pursuing MPA coursework in a non-degree status may apply for the Graduate Certificate in Public Management. The hours earned in a non-degree status may be applied to the certificate program requirements (within four years of completion of the courses).

Course Requirements

Courses are determined by the student's educational needs and career objectives and must be reviewed and approved by the MPA director. Other graduate courses may be substituted in the elective sequence with the approval of the MPA director. Program participants must maintain an overall minimum grade-point ratio of 3.0 in the certificate program. Certificate courses must be completed within a span of four years.

A graduate certificate will be awarded upon completion of 12 credit hours of study, as outlined below, and submission of a Certificate Portfolio which will consist of a compilation of the cumulative coursework accomplished in the program.

The following coursework is required:

Core Sequence—one course selected from P ADM 821, 822, 827, 829, 862

Elective Sequence—three courses selected from P ADM 867, 868, PO SC 877, 878 (topics differ by section)

Credit earned for a certificate may be applied toward the Master of Public Administration degree with the advice and approval of the MPA Director.

COLLEGE OF AGRICULTURE, FORESTRY AND LIFE SCIENCES

The mission of the College of Agriculture, Forestry and Life Sciences is to provide teaching, research and service in agriculture, forestry and life sciences that will benefit the citizens of South Carolina and the nation. The College of Agriculture, Forestry and Life Sciences serves more than 2,700 graduate and undergraduate students.

The ability to understand and manipulate the molecular structure of biological systems, while at the same time understanding their practical management, offers immense potential to improve our world, whether it is to improve foods, building products, the environment, or our health. The College of Agriculture, Forestry and Life Sciences is using the same expertise to produce more food on a shrinking globe, grow better foods that will help prevent heart disease and fight breast cancer, package environmentally sound products, increase dairy production, increase timber production and provide new fuels, and develop businesses and promote a "green" society.

The College of Agriculture, Forestry and Life Sciences offers 15 Masters and 11 Doctoral degree programs in disciplines in agriculture, forestry, a wide variety of biological sciences, from the fundamental to the applied. The college awards the MS and PhD 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.

Cooperative programs with state, federal and private agencies allow students to extend their research off campus to the Greenwood Genetics Center, research and education centers 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.

AGRICULTURAL EDUCATION

Master of Agricultural Education

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. Graduates hold positions as agriculture teachers, extension agents, agricultural and environmental agency employees, as well as human resource development specialists in the agricultural industry.

Candidates for the degree are required to plan a program of study in consultation with the major advisor and graduate committee and complete a minimum of three credit hours in adult education, three hours in research methods and three hours in statistics; a minimum of 12 credit hours in the major field; and a minimum of six credit hours in an area of concentration outside the major field.

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

Admission Requirements

Students must complete all University applications, submit undergraduate overall grade averages and GRE scores, participate in an interview with a department graduate committee, and submit a writing sample on a topic assigned by the interview committee. Desirable scores include an undergraduate overall grade-point ratio near 3.0 and GRE scores of 450/450/3.0. Acceptance will be based on an evaluation involving all of the above as well as appropriate recommendations. Provisional acceptance may be awarded and additional undergraduate coursework may be required for marginally qualified students, students without undergraduate Agricultural Education degrees, and those seeking teacher certification.

ANIMAL AND VETERINARY SCIENCES

Master of Science

Doctor of Philosophy

Applicants to the Animal and Veterinary Sciences programs should have a strong background in the animal, biological and physical sciences. Students with deficiencies in these sciences may be admitted provided they correct these deficiencies during the first year of the program of study.

MS students are required to complete coursework in an area of interest approved by their graduate advisory committee. MS students may select a thesis or non-thesis option. Students in the thesis option must complete a minimum of 30 hours of graduate coursework, including six credits of thesis research. Students in the non-thesis option must complete a minimum of 30 hours of coursework and a comprehensive oral examination.

The PhD degree program does not have formal coursework requirements, but it is recognized that students will have individual deficiencies; therefore, it is the responsibility of the student and major advisor, in consultation with the graduate advisory committee, to prescribe coursework to correct these deficiencies. A dissertation is required.

All students in Animal and Veterinary Sciences are required to complete AVS 820.

The following courses offered by various departments represent possible electives for students in Animal and Veterinary Sciences: AVS 653, 655, 803, 825, BIOCH 606, 623, 633, 634, 815, BIOSC 632, 633, 659, 660, 661, 668, 670, 671, 672, 675, 676, 677, (AVS) 680, ENT(BIOSC) 636, EX ST 801, 803, 805, MICRO (AVS, BIOSC) 614, 811.

BIOCHEMISTRY AND MOLECULAR BIOLOGY

Doctor of Philosophy

Enrollment in the Biochemistry and Molecular Biology program is open to students with appropriate degrees in agricultural, biological, or physical sciences or engineering. Entering students must have satisfactory academic records in mathematical, physical and biological sciences. Research activities include bioinformatics, functional genomics, microbial and plant biochemistry, molecular biology, proteins and signal transduction.

Degree Requirements

The PhD program requires GEN 814 and BIOCH 814 during a student's first semester; and BIOCH 805 and 890 during a student's second semester. In addition, PhD students are required to attend BIOCH 825 every semester they are enrolled. Students beyond their first year are required to do one oral presentation every year in BIOCH 825.

A student's dissertation committee will determine whether the student should take courses in addition to the required courses.

A dissertation, consisting of 18 credits of doctoral research (BIOCH 991), exclusive of any research credits earned at the master's level, is required of PhD students. Successful completion of written and oral comprehensive examinations will admit doctoral students to candidacy for the PhD degree.

BIOLOGICAL SCIENCES

Master of Science

Doctor of Philosophy

The MS and PhD degree programs in Biological Sciences encompass a wide variety of disciplines in both plant and animal biology with three major emphasis areas: Ecology and Evolutionary Biology, Cell and Developmental Biology, and Comparative Organismal Biology.

Applicants to the graduate degree programs in Biological Sciences must have a bachelor's or master's degree and a background of training in biology. All students are expected to have completed inorganic and organic chemistry, physics, calculus, biology, plant and animal diversity, genetics, and evolutionary biology. Deficiencies (less than 18 hours total) may be remedied through appropriate coursework completed during the graduate program. Graduate credit is not normally awarded for remedial coursework. Students with more than 18 hours of deficiencies, including those with degrees outside of biology, are encouraged to contact the Department of Biological Sciences to discuss options for fulfilling coursework requirements in preparation for application to the MS and PhD programs.

Candidates for the MS degree must complete 30 hours of graduate credit, including 24 credits of coursework, six credits of thesis research, an acceptable thesis based on original research and satisfactory performance in a final oral examination.

Non-Thesis Option

The non-thesis option of the MS is designed specifically for K-12 teachers and others interested in biological sciences education. Candidates must complete a total of 30 semester hours of graduate coursework. At least 18 of the 30 hours must be at the 800-level. All courses are offered online. A research proposal and project whose results are presented in written format is also a requirement. The scope of the research project is not as extensive as the thesis required in the traditional MS program; however, it is expected that students will conduct original scientific research and write a document of the caliber of a manuscript suitable for submission to a peer-reviewed journal. The student and the student's graduate committee will determine the subject of the research project.

Admission to the non-thesis option of the MS program requires a suitable undergraduate education, two letters of recommendation, a resume, and suitable GRE scores. (GRE scores are not required for teachers with one or more years of teaching experience.) Students do not need an undergraduate degree in biology to be considered for admission.

Candidates for the PhD degree must complete written and oral comprehensive examinations, 18 credits of dissertation research, an acceptable dissertation based on original research and satisfactory performance in a final oral examination. Although there is no required coursework for the doctorate beyond the 18 credits of dissertation research, some graduate coursework emphasizing breadth and depth of knowledge in the life sciences is expected of each candidate.

BIOTECHNOLOGY

Master of Science

The MS degree in Biotechnology is administered by the Department of Genetics and Biochemistry. This nonthesis degree (usually used as part of a five-year Combined Bachelor's/Master's Program) prepares students for research associate positions in the growing biotechnology and pharmaceutical industries. Students acquire a solid foundation in biotechnology theory plus knowledge of industry-oriented Good Laboratory Practices and Good Manufacturing Practices. The degree has options in Molecular Biology and in Bioprocessing.

Admission Requirements

Entering students must have a Bachelor of Science degree in a life science, agricultural, chemistry, or bioengineering field. Students entering the BS/MS program must have completed their junior year (minimum 89 credit hours) in one of these majors with a minimum grade-point ratio of 3.40. Students must have taken basic undergraduate courses in biochemistry, genetics and microbiology. A mathematics course on modeling with differential equations is recommended for the Molecular Biology Option

but required for the Bioprocessing Option. Students will be given conditional admission to the master's program pending completion of their bachelor's degree and submission of satisfactory GRE scores.

Degree Requirements

Both options require 30 credit hours, including the following core courses: B E 835, BIOCH 633, BIOCH (GEN) 805, BIOCH (GEN) 810, BIOCH (GEN) 851 (or an equivalent seminar course in the student's major), EX ST 801, GEN (BIOCH) 825. In addition, students in the Molecular Biology Option must take three credits of GEN 491 (or an equivalent research course in the student's major), GEN 640, and GEN (BIOCH) 820. Students in the Bioprocessing Option must take B E (CH E) 628, B E 638, 901 (or an equivalent research course in the student's major), and MICRO 613.

Once these requirements are met, students, in consultation with the advisor, choose from the following courses to complete the 30 credit hours required in the program: B E (CH E) 628, B E 635, 638, 838, BIO E 849, BIOCH 631, 632, 634, 643, 814, 816, 818, 821, 822, 832, 890, CH E 601, 804, CH E (EE&S) 814, EX ST 805, GEN (BIOCH) 640, 814, 890, GEN 820, MICRO 613.

ENTOMOLOGY

Master of Science

Doctor of Philosophy

The Entomology graduate programs of the School of Agricultural, Forestry and Environmental Sciences are dedicated to providing leadership in environmental entomology. Research programs fall into three emphasis areas: arthropod biodiversity, agricultural entomology, and urban entomology. Facilities of the South Carolina 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 MS degree must complete a minimum of 30 hours of graduate credit, including six hours of research, and write a thesis. Candidates for the PhD degree must complete a minimum of 60 hours of graduate credit beyond the BS/BA degree and 30 beyond the MS degree, including 18 hours of dissertation research and write a dissertation. Candidates for both degrees must satisfy a set of core requirements, some of which may have been satisfied in a previous degree program.

ENVIRONMENTAL TOXICOLOGY

Master of Science

Doctor of Philosophy

These programs are jointly administered with the Graduate School. See requirements under the Graduate School.

FOOD, NUTRITION AND CULINARY SCIENCES

Master of Science

Detailed information is available from the Department of Food, Nutrition, and Packaging Sciences or at www.clemson.edu/fnps/.

Admission Requirements

Students admitted to the MS program in Food, Nutrition and Culinary Sciences must meet the following criteria. Students not meeting the minimum requirements may be admitted in a provisional status with the approval of the graduate faculty.

1. The Aptitude Test of the Graduate Record Examination (GRE General Test) must be taken by all applicants. A minimum total GRE score of 1000 on the two-component exam is required if taken prior to August 1, 2011 and 300 if taken on or after August 1, 2011. Applicant score on the analytical writing section of the GRE should be 4.0 or higher.
2. A strong background in food science; human nutrition; physical, chemical, or biological sciences; or engineering is highly desirable.

3. Proficiency in food science must be demonstrated by satisfactory completion of coursework in the following areas: food chemistry, food microbiology, food processing, and biochemistry. Background course requirements will normally be satisfied with completion of a BS degree in Food Science from an accredited institution. Students deficient in any of these areas will be required to complete coursework to fulfill these background course requirements.

4. Acceptance is based upon academic transcripts with a minimum undergraduate grade-point ratio of 3.0, three letters of recommendation, a statement of objectives and professional experience.

5. International students must have a minimum Test of English as a Foreign Language (TOEFL) score of 550. IELTS can be taken in lieu of TOEFL. Minimum score accepted on the IELTS is 6.5. International students must also submit documentation of adequate financial support for their studies.

6. An additional requirement for admission is identification of a research advisor prepared to accept the applicant as an advisee.

Financial Aid

A limited number of research assistantships are available from grant funds, with the student assisting in the research supported under the grant. This research often may be applicable to the thesis or dissertation. Interested applicants should contact individual faculty for research assistantships. Applicants whose files are completed prior to February 15, will be given preferential consideration for research assistantships offered beginning fall semester.

Transfer of Credits

With pre-approval, up to eight graduate credits may be transferred into the MS program. A grade of B or better is required in each course transferred.

Course Requirements—Thesis Option

A minimum of 24 credit hours of coursework and six credit hours of thesis research (FD SC 891) is required for the MS degree. Only 600-level courses and higher may be used for graduate credit and at least one-half of the 24 hours of coursework must be at the 800 level or higher.

The following courses are required: EX ST 801 or equivalent, FD SC 851 (one-credit hour seminar each year), 18 credit hours of advanced-level courses (may include courses in food science or in areas such as chemistry, nutrition, biochemistry, animal and veterinary sciences, microbiology, statistics, or cell biology, as required by the student's Graduate Advisory Committee), and six credit hours of thesis research (FD SC 891).

Course Requirements—Non-thesis Option

A minimum of 30 hours of coursework as outlined below and a comprehensive, two-day final examination is required for the MS degree. The final examination consists of one day of core material and one day of content selected from departmental courses. Details may be found in the graduate handbook.

The following core courses are required: EX ST 801 or ED F 778; FD SC 810; and NUTR 803

Students select three out of the six following courses: FD SC 811, 812, 815, NUTR 804, 805, 807.

Students select eight to ten additional credit hours from 600-level or higher courses with approval of the student's graduate committee.

In addition, for both the thesis and non-thesis options, a minimum grade-point ratio of 3.0 is required to maintain good academic standing and for graduation.

**Combined BS in Food Science/
MS in Food, Nutrition and Culinary
Sciences**

Under this plan, students may reduce the time necessary to earn both degrees by applying graduate credits to both undergraduate and graduate program requirements. Enrollment guidelines and procedures can be found in the *Undergraduate Announcements*. Consult the Department of Food, Nutrition and Packaging Sciences for details.

FOOD TECHNOLOGY**Doctor of Philosophy**

Students admitted to the PhD program in Food Technology must meet the following criteria. Students not meeting the minimum requirements may be admitted in a provisional status with the approval of the graduate faculty.

1. The Aptitude Test of the Graduate Record Examination (GRE General Test) must be taken by all applicants. A minimum total GRE score of 1000 on the two-component exam is required if taken prior to August 1, 2011 and 300 if taken on or after August 1, 2011. Applicant score on the analytical writing section of the GRE should be 4.0 or higher.

2. A strong background in food science; human nutrition; physical, chemical, or biological sciences; or engineering is highly desirable.

3. Proficiency in food science must be demonstrated by satisfactory completion of coursework in the following areas: food chemistry, food microbiology, food processing, and biochemistry. Background course requirements will normally be satisfied with completion of a BS degree in Food Science from an accredited institution. Students deficient in any of these areas will be required to complete coursework to fulfill these background course requirements.

4. Acceptance is based upon academic transcripts with a minimum undergraduate grade-point ratio of 3.0, three letters of recommendation, a statement of objectives and professional experience.

5. International students must have a minimum Test of English as a Foreign Language (TOEFL) score of 550. IELTS can be taken in lieu of TOEFL. Minimum score accepted on the IELTS is 6.5. International students must also submit documentation of adequate financial support for their studies.

6. An additional requirement for admission is identification of a research advisor prepared to accept the applicant as an advisee.

Financial Aid

A limited number of research assistantships are available from grant funds, with the student assisting in the research supported under the grant. This research often may be applicable to the thesis or dissertation. Interested applicants should contact individual faculty for research assistantships. Applicants whose files are completed prior to February 15, will be given preferential consideration for research assistantships offered beginning fall semester.

There are no set course requirements for the doctorate in Food Technology. It is expected that each PhD graduate will have a comprehensive understanding of the principles of food science with an expanded knowledge covering their focused research area. The PhD candidate's research committee will have final approval on all coursework. PhD candidates must pass both written and oral examinations given by the student's advisory committee. The successful student must also write and defend a dissertation to the satisfaction of the advisory committee. Dissertations usually contain a review of the literature and a detailed description of research in a scientific publication format. PhD students should expect to publish a minimum of two refereed research manuscripts from their dissertations.

FOREST RESOURCES**Master of Forest Resources****Master of Science****Doctor of Philosophy**

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 credit hours of graduate coursework with at least 18 of the required hours selected from courses numbered 700 or above.

A formal thesis is required for the MS and PhD degrees. The MS degree requires a minimum of 24 credit hours of coursework and six hours of research. The PhD degree requires a minimum of 16 credit hours of coursework and 18 hours of research beyond the student's master's degree coursework. For both degrees, one-half of the semester hours must be selected from courses numbered 800 and above.

GENETICS**Doctor of Philosophy**

The PhD degree in Genetics is administered by the Department of Genetics and Biochemistry. Research activities include biochemical, biometrical, molecular and population genetics, as well as bioinformatics, cytogenetics, and structural and functional genomics through arrangements with other participating disciplines and with the Greenwood Genetics Center.

Degree Requirements

The PhD program requires GEN 814 and BIOCH 814 during a student's first semester; and GEN 805 and 890 during a student's second semester. In addition, PhD students are required to attend GEN 825 every semester they are enrolled. Students beyond their first year are required to do one oral presentation every year in GEN 825.

A student's dissertation committee will determine whether the student should take courses in addition to the required courses.

A dissertation, consisting of 18 credits of doctoral research (GEN 991) exclusive of any research credits earned at the master's level, is required of PhD students. Successful completion of written and oral comprehensive examinations will admit the doctoral students to candidacy for the PhD degree.

MICROBIOLOGY**Master of Science****Doctor of Philosophy**

The Department of Biological Sciences administers the MS and PhD degree programs in Microbiology. The Microbiology graduate programs includes a wide variety of disciplines with three major emphasis areas: Cellular and Physiological Microbiology, Microbial Genetics and Molecular Microbiology, and Environmental Microbiology.

Applicants to the graduate degree programs in Microbiology must have a bachelor's or master's degree and a background of training in biology (botany, microbiology, or zoology), chemistry, or in one of the agricultural sciences. Undergraduate work in bacteriology or microbiology is desirable but not necessary. All students are expected to have completed inorganic and organic chemistry, physics, calculus, general biology and genetics. Deficiencies (less than 18 hours total) may be remedied through appropriate coursework completed during the graduate program. Graduate credit is not normally awarded for remedial coursework. Students with more than 18 hours of

deficiencies including those with degrees outside of biology, chemistry, or agricultural sciences are encouraged to contact the Department of Biological Sciences to discuss options for fulfilling coursework requirements in preparation for application to the MS and PhD programs.

Candidates for the MS degree must complete 30 hours of graduate credit, including 24 credits of coursework, six credits of thesis research, an acceptable thesis based on original research, and satisfactory performance in a final oral examination. The 30 credits of graduate coursework will include courses from each of the following areas: cellular and physiological microbiology, microbial genetics and molecular microbiology, and environmental microbiology.

Candidates for the PhD program must complete written and oral comprehensive examinations, 18 credits of dissertation research, an acceptable dissertation based on original research, and satisfactory performance in a final oral examination. Although there is no required number of credits of coursework for the doctorate beyond the 18 credits of dissertation research, a core of graduate coursework including courses from each of the following areas is expected of each candidate: cellular and physiological microbiology, microbial genetics and molecular microbiology, and environmental microbiology.

PACKAGING SCIENCE

Master of Science

The MS degree program in Packaging Science prepares graduates 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 MS degree in Packaging Science requires 30 hours of coursework, six of which are thesis research, and the completion of an acceptable MS thesis. In addition to PKGSC 891, students register for at least one credit of PKGSC 851.

The following courses represent possible electives for the student in Packaging Science: C M E 815, CH E 612, 804, EX ST 801, 802, FD SC 601, 602, 604, 606, 608, 810, 811, 812, G C 606, 607, 648, MKT 627, 630.

Combined Bachelor of Science/ Master of Science Degree Program

The Department of Food, Nutrition, and Packaging Sciences also offers an accelerated five-year combined bachelor's/master's program that allows students to count up to 12 hours of graduate credit toward both the BS degree in Packaging Science and the MS degree in Packaging Science. Details are available from the Department of Food, Nutrition and Packaging Sciences or at www.clemson.edu/fnps.

PLANT AND ENVIRONMENTAL SCIENCES

Master of Science

Doctor of Philosophy

The degree programs in Plant and Environmental Sciences are offered through an interdepartmental program comprised of faculty from disciplines including biological sciences, botany, crop science, entomology, genetics, environmental horticulture, plant pathology, plant physiology and soil science.

Candidates for the program in Plant and Environmental Sciences should have a strong undergraduate background in the biological, agricultural and/or physical sciences as appropriate to their focus areas. Undergraduate curricula that may provide this background are botany, biology, chemistry, or one of the agricultural plant and soil environmental sciences such as agronomy, forest resources, or horticulture. Students with nontraditional backgrounds may need to complete some relevant undergraduate courses to supplement the graduate program.

Each student's degree program is tailored to his/her professional goals and is guided by an advisor and graduate committee with expertise appropriate to the student's area of specialization. All graduate students must select an advisor before admission.

Candidates for the MS degree must complete 24 credit hours of coursework and six hours of research, and they must present and defend a thesis based on original research. MS students who plan nonresearch-related careers in public gardening, landscape design, extension, consulting, or agribusiness may complete 30 credit hours of coursework and undertake a professional development/public service project option in lieu of thesis-related research. Interdisciplinary studies in plant health and integrated pest management are also available under this option.

A dissertation based on original research is required for the PhD degree. There is no specific credit hour requirement; the plan of coursework is based on the student's interests and dissertation emphasis, as determined in consultation with the major advisor and graduate committee.

Individual plans of study include courses from the following areas: biochemistry, biological sciences, botany, crop and soil environmental science, entomology, genetics, horticulture and plant pathology as well as plant and environmental sciences.

WILDLIFE AND FISHERIES BIOLOGY

Master of Science

Doctor of Philosophy

Those who are interested in pursuing a graduate degree in Wildlife and Fisheries Biology 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 requires acceptance by the University and the Graduate Student Admission Committee of Wildlife and Fisheries Biology. This committee will base its acceptance recommendation to the Graduate Admissions Office on previous coursework, GRE scores, letters of recommendation, undergraduate background and current research interests. Students are required to have completed a bachelor's degree, preferably in a natural science, with a minimum of 30 credit hours in natural sciences. In addition, an MS in Natural Resource Biology or related area usually is preferred, but not required, for acceptance into the doctoral program. Students accepted without the appropriate course background will be required to make up these deficiencies as outlined by the Graduate Student Admission Committee and consistent with University admission policies.

Students seeking the MS degree in Wildlife and Fisheries Biology may select a thesis or a non-thesis option. Requirements for the thesis option include a minimum of 24 credit hours of coursework, six hours of thesis research (W F B 891), an acceptable thesis based on original research, and satisfactory performance on a final oral examination/thesis defense. Additional coursework usually includes subjects such as experimental statistics, biological sciences and forestry. Thesis research areas include conservation biology, wildlife management, endangered species, freshwater fisheries science and wildlife toxicology.

The non-thesis option is designed primarily for students with substantial experience in natural resources who wish to enhance their professional degree skills. Students in the non-thesis option are not allowed to transfer to the thesis option without approval by vote of the faculty of the Department of Forestry and Natural Resources. Candidates must complete a minimum of 30 credit hours of approved courses, including three to six hours of W FB 863, which result in a broad, well informed and integrated exposure to natural resources management and environmental issues. The non-thesis project must be substantial in nature and result in an extended report addressing a major problem or issue relevant to the field of wildlife management, fisheries management, natural resources or environmental studies. The scope of the project should be consistent with the credit hours awarded for the project. A maximum of three credit hours from independent studies (W F B 861 or similar courses) may be applied toward the coursework requirement.

The graduate advisory committee ensures appropriate elective course selection and may require a student to complete more than 24 credits if deficiencies in the student's background exist or if additional courses are required for professional certification. Students are also required to pass a final oral examination.

The PhD degree program requires a minimum of 30 credit hours beyond the student's master's degree coursework or 60 credit hours beyond the student's bachelor's degree coursework. While the PhD program has no specific credit hour requirement beyond that, the student's advisory committee will insist on a rigorous and appropriate program of study and research. Students are required to take, or have taken, at least two semesters of graduate statistics and two semesters of 800-level seminars in fisheries and wildlife science or related areas. Students must also have at least one semester of professional experience, which will be evaluated by the advisory committee. Examples of appropriate professional experience are teaching assistantships, internships or cooperative study program participation, or natural resource agency employment. Other course requirements will be identified by the student's advisory committee and will include specific courses according to the elected emphasis area: fisheries biology, wildlife biology, or conservation biology.

Research opportunities are enhanced by cooperative programs with the S.C. Department of Natural Resources, U.S. Geological Survey Cooperative Research Unit at Clemson, Savannah River Ecology Laboratory, Webb Wildlife Research Center, and Waddell Mariculture Center. The department also is associated with the National Council for Air and Stream Improvement Eastern Wildlife Program. The graduate program is accredited by the Southeastern Section of the Wildlife Society.

Combined BS/MS in Wildlife and Fisheries Biology

Under this plan, students may reduce the time necessary to earn both degrees by applying graduate credits to both undergraduate and graduate program requirements. Students should obtain specific requirements for the dual degree from the School of Agricultural, Forestry and Environmental Sciences as early as possible in their undergraduate program to ensure that all prerequisites are met. Enrollment guidelines and procedures can be found in the *Undergraduate Announcements*.

2012-13

COLLEGE OF ARCHITECTURE, ARTS AND HUMANITIES

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. Advanced degrees are offered in Architecture; City and Regional Planning; Communication, Technology and Society; Construction Science and Management; Digital Production Arts; English; Historic Preservation; History; Landscape Architecture; Planning, Design and the Built Environment; Professional Communication; Real Estate Development; Rhetorics, Communication and Information Design; and Visual Arts.

Courses are offered in art and architectural history, communication studies, geography, languages, literature, performing arts, philosophy, religion and women's studies to provide electives for students in other areas.

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, or the Clemson Architectural Center in Charleston, SC. The Genoa and Charleston programs offer opportunities for international and/or urban study to augment on-campus work. Lee Hall, the on-campus home of the School of Design and Building, as well as the Department of Art, is in the design phase of a major expansion and renovation. The new building is designed to promote collaboration between the various professional programs within Lee Hall, allow students to interact with faculty and students from related disciplines addressing contemporary issues of design, planning, development and construction. Issues of sustainability and green building are among the areas of particular interest. Faculty research activities are currently funded by the National Science Foundation, National Institutes of Health, National Oceanic and Atmospheric Administration, USEPA, Department of Transportation and Department of Defence.

The School of Humanities houses programs leading to the Master of Arts in Communication, Technology and Society; English; History; and Professional Communication; and the Doctor of Philosophy in Rhetorics, Communication and Information Design. The school also offers a certificate program in Health 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, the John Simon Guggenheim Memorial Foundation, and the Bingham Trust. They have also held Fulbright Senior Lectureships and Research Awards in many countries.

ARCHITECTURE

Master of Architecture

Master of Science

In the United States, most state registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB), which is the sole agency authorized to accredit U.S. professional degree programs in architecture, recognizes three types of degrees: the Bachelor of Architecture (B. Arch.), the Master of Architecture (M. Arch.), and the Doctor of Architecture (D. Arch.). A program may be granted a 6-year, 3-year or 2-year term of accreditation, depending on the extent of its conformance with established educational standards.

Doctor of Architecture and Master of Architecture degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree that, when earned sequentially, constitute an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree.

Clemson University, College of Architecture, Arts and Humanities, School of Architecture, offers the following NAAB-accredited degree programs:

M.Arch (pre-professional degree + 60 credits)
 M.Arch + Health (pre-professional degree + 61 credits)
 M.Arch (non-pre-professional degree + 90 credits)
 M.Arch + Health (non-pre-professional degree + 91 credits)

Admission to the M. Arch. program, and any advanced placement, is based on an estimation of the applicant's ability to respond effectively to the intellectual rigor and creative challenge integral to graduate architecture study by an admissions committee of graduate faculty. The applicant's potential is measured in part by demonstrated proficiency in prior academic work, Graduate Record Examination (GRE) test scores, a portfolio of design work (required of all applicants), and other application requirements. More detailed information is available on the School of Architecture Web site.

The Master of Architecture program develops proficiency in responding to contemporary architectural issues through a range of practical and theoretical knowledge, while providing opportunities for creatively challenging the limits of the profession. Emphasis is on design, accompanied by complementary coursework 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.

The Master of Architecture degree requires a minimum of two academic years. Degree candidates may elect a concentration of study in architecture or architecture and health. The graduate faculty reviews each student each semester of the first year to determine if his/her performance is acceptable to continue in the program.

Architecture Concentration

This inclusive course of study leading to the MArch degree allows the student 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 range of theoretical and real-world explorations. However, sufficient elective hours are available to establish a study plan responsive to individual interests.

Architecture + Health Concentration

Within the framework of the Master of Architecture degree, the Architecture + Health Concentration includes seminar courses and studio work appropriate for both a general professional degree and a concentration in Architecture + Health. The intent is to develop the generalist-specialist—graduates who can creatively work in both modes. This concentration includes both the study of health facility design and the study of relationships between architectural settings and their impact on human health and well-being. The primary purpose of the concentration is to study how architectural environments impact health and how to create architectural settings that support health and well-being of individuals and larger populations.

Studio design projects and courses examine these relationships for architectural settings and conditions ranging from entire communities and health care systems to specific projects and individual interior or exterior spaces. The studio emphasizes design excellence within the framework of rigorous and complex demands found in the practice of health care architecture. Student work is expected to stand up critically at all levels of architectural consideration.

The Architecture + Health Concentration is demanding in the scope of its professional studies, with most of the coursework designated for specific areas of learning. Students may take advantage of the same off-campus programs available to students in the Architecture Concentration during their first semester of study. Given the number of required courses, students may opt for a five-semester plan of study beginning in the spring semester. The thesis or project, developed during the final year, normally deals with particular architectural topics as they relate to health and/or health facility design.

Master of Science Program

The Master of Science degree in Architecture is a post-professional degree program that 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 coursework, accompanied by directed studies within a selected area, and followed by the critical examination of a singular aspect of architecture in a research thesis.

Admission to the MS program is available to students who have a first professional degree in architecture and who possess the intellectual mettle and dedication 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. Information concerning application procedures and requirements is available from the School of Architecture.

The coursework 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 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 plan of study is determined in consultation with the major advisor who, along with the advisory committee, periodically reviews the student's work and evaluates the research thesis. Requirements for the MS degree consist of 24 credit hours of combined coursework and directed studies with a minimum grade-point ratio of 3.0 and the acceptance of a six-hour research thesis.

CITY AND REGIONAL PLANNING

Master of City and Regional Planning

The two-year Master of City and Regional Planning program is a professional degree emphasizing applied study in preparing tomorrow's leaders for planning and developing the nation's towns, cities and regions. The curriculum emphasizes applied study preparing for the challenge of planning vibrant and sustainable communities. Graduates are well-equipped for careers in private sector planning and development, as well as public sector planning and administration. The nationally accredited program began in 1968 and has more than 500 graduates.

The program emphasizes sustainable land development, applying appropriate technology and recognizing the balance of physical, economic, financial, social and policy dimensions of planning. The program has a professional application focus mainly concerned with providing a solid planning education to qualified students, primarily to meet the needs of South Carolina, the southeastern region and the nation. The generalist approach is employed with the flexibility for specialization in four areas: development planning, transportation, environmental land use planning and geographic information systems. A substantive core emphasizes the general framework, theories, methods and applications of the planning process. Strong ties with the professional community reinforce the professional application focus.

Students come from a variety of undergraduate majors and professional backgrounds—primarily liberal arts, the social sciences, environmental science, business, management and design—and from many states and several countries. The MCRP program typically has annual classes of approximately 20 students, providing the opportunity for extensive faculty involvement in teaching, research and public service.

While the curriculum covers theory and policy issues, the principal focus emphasizes the applied skills students need to enter the job market as professional planners and to evolve as leaders in the field. Classes use real-world situations for analysis and for the application of planning skills in dealing with land use planning, development and issues of the built and natural environment.

Planning students are equipped to meet opportunities facing communities in many creative ways. Many first-year students work two days per week as department assistants for professors or in planning related entities. Students typically work full time as interns in planning or development organizations during the summer. During their second year, most students work two days a week with a public, private or nonprofit entity as student public service assistants (PSA). This allows them to gain additional professional experience.

Department assistants generally earn around \$3,500 for nine months at 10 hours per week; PSAs earn around \$4,500 at 15 hours per week and usually require an automobile for transportation to positions throughout the area. Both assistantships provide significant tuition reduction. Students are actively involved in Clemson's Planning Student Organization of the American Planning Association (APA) and the South Carolina APA (SCAPA).

Clemson's graduates have been successful in the public, private and nonprofit sectors, attaining key positions in traditional planning agencies, development groups, nonprofit organizations and private consulting firms. This practical, applied program is recognized throughout the region for its outstanding graduates. Most alumni of the program serve as agency directors, department heads and staff planners at the local, regional and state levels. Some graduates work as generalists while others are specialists in GIS, housing and community development, environmental and coastal planning, historic preservation, transportation planning, or economic development. A growing number are employed in the private sector as planning or urban design consultants, developers, and market research or environmental analysts.

Admission Requirements

1. A bachelor's degree from an accredited college or university
2. A satisfactory academic record, particularly in the last two years of undergraduate work
3. An on-campus interview (highly recommended)
4. Three letters of recommendation with at least two from current or former professors
5. Completion of the Graduate Record Examination
6. International applicants must submit TOEFL scores.
7. A personal statement of objectives, briefly describing (in one to two pages) the applicant's interest in planning in general and Clemson's program in particular

Courses in statistics and economics are highly recommended.

Requirements for Degree Candidacy

The two-year Master of City and Regional Planning degree requires a minimum of 54 credit hours. The program contains a 28-credit core curriculum, a three-credit summer internship, 15–18 credit hours of approved concentration/elective courses, and 6–9 hours of research and terminal project or thesis. The core courses include planning and substantive theory, analytical methods, implementation techniques and

applications. The concentration area allows the student to develop further expertise in a particular area, if desired. A summer internship between the first and second years requires ten weeks of supervised professional employment for another three credits. If approved, students may take additional coursework in lieu of the internship. An oral examination is required to present and defend the results of the terminal project or thesis.

Requirements for Awarding of a Degree

Thesis Option

1. A minimum of 54 hours of coursework with a B average in the student's prescribed professional curriculum, including the thesis, is required.
2. A nine-credit-hour planning thesis must be completed satisfactorily. Only those students who have been approved by the Planning faculty are permitted this option.
3. The final oral examination requires satisfactory answers to questions concerning the student's thesis and concentration area.

Nonthesis Option

1. A minimum of 54 hours of coursework with a B average in the student's prescribed professional curriculum is required.
2. An approved six-credit-hour terminal project sequence must be completed satisfactorily.
3. The final oral examination requires satisfactory answers to questions concerning the student's terminal project and concentration area.

COMMUNICATION, TECHNOLOGY AND SOCIETY

Master of Arts

The Master of Arts in Communication, Technology and Society examines how people use technology to pursue long-term communication goals, including interpersonal, group, identity, and community relations, decision-making, virtual organizing, and health, political, and social movement campaigns. The program emphasizes the impacts and interconnections of communication technologies in society and culture from the full range of theoretical and methodological approaches. Graduates are prepared to enter teaching, business, politics, or social organizing as communication practitioners with expertise in a variety of fields, directly impacting economic development in the region and across the nation, or to continue their education through the doctoral level at major research universities.

Departmental faculty are committed to providing students with opportunities for academic and professional development and believe that individuals continue to develop their expertise throughout their careers. The MA program provides a variety of opportunities to engage in scholarly and professional development activities outside the classroom, including participation in colloquia offered by communication scholars, professional workshops, internships, applied projects, and study abroad. Students are encouraged to become active members of international, national, regional, and state academic

and professional associations, and to participate in as many of these development activities as possible while at Clemson in order to build network contacts in the communication discipline before graduation.

Certification/Employment

Most full-time graduate students are awarded assistantships. Students are automatically considered for an assistantship when applying to the program unless they request otherwise. For example, students may not wish to be considered for an assistantship if they plan to pursue the degree part-time while continuing to work full-time.

Funding opportunities are available to approximately eight new graduate students per year in the form of teaching and research assistantships. Assistantships provide a full tuition waiver and a stipend of approximately \$12,000 per academic year, and are awarded competitively by the graduate committee. A variety of opportunities are available for students to grow as teachers, scholars, and emerging professionals in the discipline. Graduate students typically assist with the delivery of basic undergraduate courses and assist faculty members with research.

Admission Requirements and Application Process
The Department of Communication Studies welcomes applications from students and professionals who want to further their knowledge and skills in communication studies. Priority for admission and assistantship funding is given to applicants who apply by February 1 for the fall semester. However, applications may be reviewed after the deadline until all spaces are full. Students begin the program in the fall semester. At this time, students may not begin the program in the spring semester.

The following credentials are preferred, though the entire application is considered holistically: bachelor's degree from an accredited college or university; GPA of 3.0 or better on a 4.0 scale; scores of 500/500/4.0 or better on the GRE (verbal/quantitative/writing); TOEFL scores of 600 or better for the paper exam or 267 or better for the online exam (for non-native English language speakers only); strong writing skills as demonstrated through a writing sample and curriculum vitae; and focused reasons for pursuing a master's degree in communication, technology, and society as demonstrated in curriculum vitae and statement of purpose.

Applicants should complete Clemson University's online Application for graduate admission and mail the following documents to the Office of Graduate Admissions: official GRE scores from ETS; official TOEFL/IELTS scores (international students); official college or university transcripts; and three letters of recommendation from teachers or supervisors addressing the applicant's preparation for graduate school (e.g., written/oral communication skills, analytic and critical thinking abilities, leadership, imagination, aptitude for and experience with technology, potential success as a teacher, scholar, or communications professional, ability to work in a collegial and collaborative environment, professionalism, etc.) In addition to the mailed application package, applicants should e-mail the following documents to Dr. Travers Scott, Graduate Program Director, Department of Communication Studies, dscott3@clemson.edu: statement of

purpose (500 word limit, double-spaced) describing their experience, goals, reasons for pursuing this degree, and unique contributions they can make to it; curriculum vitae including mailing address, e-mail address, phone number, and URLs for any online projects; and a writing sample illustrating excellence in relevant professional or academic writing, or one sample of each for two total.

Financial Aid

A number of graduate assistantships are offered to students each year based on merit in the form of stipends and the additional benefit of tuition remission. Students must be enrolled in a minimum of nine credit hours per semester to qualify for a graduate assistantship and must work 10 hours a week as a teaching or research assistant or perform other tasks assigned by the school.

Degree Requirements

Students may select the thesis option or the comprehensive exam option. In either case, students must complete a minimum of 30 credit hours, including COMM 801, 802, 803, 810 and 811; a minimum of 18 credits in COMM courses at the 800 level; and a minimum of six credits in a field other than COMM selected in consultation with the student's advisor. Up to nine credit hours of thesis work may be applied to the coursework requirements. The number of elective courses selected in a specialty area depends on which option a student selects. After students complete all required coursework, they begin work on a thesis or preparing for the comprehensive exams.

Students selecting the thesis option complete and publicly defend a project representing a significant contribution to the body of knowledge regarding the communication phenomenon that is the focus of the thesis project. A thesis committee is selected in consultation between the student and his/her advisor and is comprised of faculty from the Department of Communication Studies, but may also include faculty representing associated disciplines on the Clemson campus.

Students selecting the comprehensive exam option are assessed in their knowledge in several areas, such as the history and distinguishing characteristics of the communication discipline, relevant communication theory, the range of research methods used in communication research, communication ethics as they apply to communication mediated by technology, how communication mediated by technology may be used to pursue long-term goals in communication (e.g., social movements, health, community, interpersonal, small group, organizational), the relations between communication technologies and social and cultural identities and institutions, and material representative of the student's identified area of emphasis. The exam committee is selected in consultation between the student and his/her advisor and is comprised of faculty from the Department of Communication Studies, but may also include faculty representing associated disciplines on the Clemson campus.

Additional information about the MS in Communication, Technology and Society is available at <http://www.clemson.edu/caah/communication/graduate/index.html>.

CONSTRUCTION SCIENCE AND MANAGEMENT

Master of Construction Science and Management

Certificate

The Master of Construction Science and Management thesis-optinal program provides students with a high level of skills and knowledge 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 number of credit hours required for the MCSM degree varies according to each student's undergraduate degree. For those who have the required undergraduate skills and knowledge, the program consists of 36 credit hours. In cases where the candidate does not have the necessary prerequisite skills and knowledge, additional coursework beyond the 36 credit hours is required. Each application is evaluated as to the needed additional coursework. Up to 12 credits of approved recent graduate courses can be transferred into the program from another accredited institution.

This program is also available to off-campus students through the Office of Off-Campus, Distance and Continuing Education. Call 1-888-CLEMSON (1-888-253-6766) for more information.

Admission Requirements

1. A bachelor's degree in construction science, construction management, building construction, or related area is required. Applicants from other disciplines may be admitted but may be required to remedy any deficiencies in coursework to provide the prerequisite skills and knowledge for the program.

2. Acceptance must be granted by the Office of Graduate Admissions and the Department of Construction Science and Management. University acceptance is based on performance in previous undergraduate studies and a satisfactory score on the GRE. International students must also achieve a satisfactory score on the TOEFL. In addition, acceptance by the department is based on performance in undergraduate studies, three letters of recommendation and acceptance by the department Graduate Admissions Committee.

3. Each applicant is required to have one year of construction experience prior to being admitted to the program. Applicants must submit a detailed résumé of construction experience.

Requirements for Degree Candidacy

The Master of Construction Science and Management degree requires a minimum of 36 credit hours as detailed above. In cases where the candidate does not have the necessary undergraduate prerequisite skills and knowledge, additional coursework beyond the 36 semester hours may be required as noted above.

Requirements for Awarding of a Degree

Thesis Option:

1. A minimum of 36 semester credit hours of which the following courses are required: CSM 852 (three credits); CSM 891 (nine credits) and 12 additional credits selected from CSM 860, 861, 862, 863, 864 or 865. The remaining credits should be selected from the program's core and other master's degree courses (CSM 665, 881 and 890), any approved graduate course offered by another department and/or CSM Chair approved graduate courses transferred in from another accredited university. Up to 12 credits may be transferred from other Clemson University approved institutions.

2. A thesis on a construction-related topic must be completed satisfactorily. Up to nine semester hours of thesis credit may be taken. Thesis credit is included as part of the department's core. Approval must be received from the student's advisor prior to selecting the thesis option.

3. Performance on a final oral examination relating to the student's thesis and program of study must be satisfactory.

Nonthesis Option

1. A minimum of 36 credit hours of which 12 must be from the department core (CSM 860, 861, 862, 863, 864 and 865) and CSM 852 and 889. The remaining credits should be selected from the program's core and other master's degree courses (CSM 665, 881 and 890), any approved graduate course offered by another department and/or CSM Chair approved graduate course transferred in from another university. Up to 12 credits may be transferred from another Clemson University approved institution.

2. Performance on a written comprehensive examination covering the student's program of study must be satisfactory.

3. Performance on a final oral examination relating to the student's program of study must be satisfactory if the student has not performed satisfactorily on the written comprehensive exam.

Certificate of Construction Science and Management

Clemson University's Certificate Program in Construction Science and Management provides qualified students the opportunity to take a selection of advanced construction management courses without having to commit time and resources toward the pursuit of a master's degree. Students receive three hours of college credit for each course taken and a certificate upon completion of all six courses.

Prospective students apply in the same manner as current graduate students. A bachelor's degree in construction science, construction management, building construction, or related area is required. There is no requirement to take the GRE or TOEFL.

A student enrolled in the certificate program who wishes to be admitted into the MCSM graduate program must meet all admission and degree requirements in effect at the time of application. The student may transfer up to 12 credit hours from the certificate program to the Master of Construction Science and Management degree; therefore, the decision must be made by the time the student has completed four courses (12 credit hours).

Admission Requirements

1. A bachelor's degree in construction science, construction management, building construction, or related area is required. Applicants from other disciplines may be admitted but may be required to remedy any deficiencies in coursework to provide the applicant with the needed prerequisite skills and knowledge for the Construction Science and Management certificate program.

2. Acceptance must be granted by the Department of Construction Science and Management. Acceptance is based on performance in previous undergraduate studies, three letters of recommendation and acceptance by the department graduate admissions committee.

3. Each applicant is required to have a minimum of one year of construction experience prior to being admitted to the program. Applicants must submit a detailed résumé of construction experience.

Requirements for Awarding of a Certificate

Completion of the following courses with a B or better is required: C S M 860, 861, 862, 863, 864, 865.

DIGITAL PRODUCTION ARTS

Master of Fine Arts

The Digital Production Arts program is a professional degree program offered jointly with the College of Engineering and Science. See details in the College of Engineering and Science section.

ENGLISH

Master of Arts

The Master of Arts in English (MAE) offers a comprehensive approach to literary studies, incorporating exploration of literary texts and theory, examination of textuality and modes of publication, and a foundation in methods of research and scholarship. Through coursework, close interactions with faculty, and individual research projects, students infuse their broad understanding of the field of English studies with their own particular literary interests and concerns. The curriculum offers courses in theory, literary periods and genres, film, new media, creative writing, cultural studies, and rhetoric. The MAE program serves three types of students: those who plan to pursue graduate studies in literature or creative writing at the doctoral or terminal level; those aiming to teach in high schools, community colleges, and technical colleges; and those who want to enrich their background in English studies, develop research and writing skills, and continue their intellectual experience beyond the baccalaureate.

Preference for admission is given to applicants with 12 undergraduate credit hours or English or other background that prepares them for the program. Candidates for the MAE degree also must demonstrate proficiency in composition.

MAE students complete 31 credit hours of approved graduate courses, which may include up to six credits at the 600 level. MAE students write a semester-long, potentially publishable thesis paper of 25-30 pages, developed from a seminar paper and presented in a public defense. All students must demonstrate a reading knowledge of an approved foreign language.

At the core of the MAE program is a 16-hour requirement, including ENGL 800, 810, 891, and one course from each of the following groups:

Literature before 1800—ENGL 805, 808, 811, 820, or an appropriate course selected from 802, 803, 831, or 835

Literature after 1800—ENGL 814, 823, or an appropriate course selected from 802, 803, 831, or 835

Students applying for second-year graduate teaching assistantships must take ENGL 885.

Students interested in pursuing an MEd in Teaching and Learning with a concentration in English should consult the School of Education.

HISTORIC PRESERVATION

Master of Science

The Master of Science in Historic Preservation degree is a professional degree program designed for students who will specialize in working with historic buildings, landscapes and the decorative arts. It is a dual degree program with the College of Charleston and is administered through Clemson's Department of Planning and Landscape Architecture. The program uses Charleston and the historic environs of South Carolina as a living laboratory. The size of the program is restricted to ensure focused research with the faculty. Coursework emphasizes studios, labs and field seminars incorporating Charleston's rich community of preservation specialists as well as distinguished visiting faculty and researchers.

Students are admitted into the program from a variety of undergraduate disciplines relating to the built environment. A portfolio with samples of work related to the built environment is encouraged. Students of the humanities and sciences are also encouraged to apply.

Program Requirements

The 54-credit program is structured in sequential layers, beginning with an initial core semester devoted to the analysis and documentation of historic sites, followed by a more advanced studio-focused semester organized around the development of a preservation project. The second year focuses on advanced analysis and conservation studies, followed by a final semester of preservation administration done in conjunction with the student's final project/thesis focus.

Thesis proposals are defended in the third semester of the program. Thesis projects are original research and incorporate each student's specific focus in the discipline of historic preservation. Projects using the historic resources of Charleston and its environs, or other suitable historic sites, are encouraged.

Summer professional internships are available through a variety of Charleston preservation initiatives, the national network of preservation specialists, as well as opportunities with national organizations such as the Historic American Building Survey and the National Trust for Historic Preservation.

Certificate in Historic Preservation

The Certificate in Historic Preservation is designed to enhance a variety of other degree programs at Clemson through advanced studies in historic preservation.

The 12-credit semester meets NCPE-mandated curriculum requirements. Prerequisites and further course requirements are determined by the student's degree program of study.

HISTORY

Master of Arts

Admission Requirements

Students are admitted to the graduate program upon the recommendation of the department's graduate program coordinator or department chair. All applicants to the MA program in History must submit the following to the Graduate Admissions Office:

1. A minimum score of 550 on the verbal section of the Graduate Record Examination (GRE) and a minimum score of 5 on the writing section. (GRE scores more than five years old relative to date of initial enrollment are not accepted.)
2. Final transcript(s) for the BA sent by the applicant's undergraduate school(s), showing a minimum grade-point ratio of 3.0 in history courses; and 2.5 in all courses during the last two undergraduate years
3. Three letters of reference, preferably from undergraduate professors
4. A sample term paper

5. A personal statement addressing the applicant's background in history, intended areas of specialization and reasons for applying

6. A completed University application form

Additionally, if the applicant has (1) a grade-point ratio less than 3.0 in the History major for the BA degree and/or (2) a BA degree, including the major and minor, in subject(s) other than history, he/she will be required to take a minimum of four upper-level undergraduate history courses at Clemson or at another accredited university or college and receive a grade of B or better in each course before admission to the program. The only exception to this course requirement shall be persons who demonstrate that, as a part of their BA degrees, they completed a minimum of four upper-level undergraduate history courses with a grade of B or better. Any exceptions to these regulations require the consent of the department's Graduate Committee.

Application Deadline

Applications for fall semester must be postmarked no later than the previous February 20, and for spring semester no later than the previous November 1. Please note that consideration for assistantships begins in January and continues until all available slots are filled.

Requirements for Awarding of a Degree

The MA in History requires 30 credit hours in courses numbered 600 or above divided as follows:

1. HIST 881
2. HIST 820 or 872 and HIST 890
3. A minimum of nine additional credit hours in courses numbered between 800 and 894, excluding HIST 885, 890, and 891
4. A minimum of nine elective credits in graduate courses selected with the approval of the director of the graduate program
5. A minimum of five credits in HIST 891 (Master's Thesis Research), three of which should be taken in the second semester if enrolled full-time or within the first 18 credits in the program. Additionally, the student must write a thesis acceptable to the department and must demonstrate reading knowledge of a foreign language. A final examination, which may be written, oral, or a combination of the two forms, is required of all candidates.

Students holding an assistantship in the Department of History who receive a grade lower than B in any graduate course may have their assistantships terminated.

LANDSCAPE ARCHITECTURE

Master of Landscape Architecture

The landscape architecture profession is broad and interdisciplinary. Practicing landscape architects work on a wide range of project types including, but not limited to, urban and community design, historic preservation, ecological restoration, parks and park systems, institutional landscapes, memorials, cemeteries, industrial site reclamations, golf courses, wilderness areas and trails, residential landscapes and gardens. The profession is both an art and a science. Successful landscape architects are creative professionals who hold an environmental imperative and a social conscience. They are also excellent facilitators, able to bring numerous disciplines and professions together to work on complex projects in the landscape.

Like other universities in the United States, Clemson offers two Master of Landscape Architecture (MLA) tracks—a first professional degree and a second professional degree. Research and study in those important topics of national and international consequence further ensure the marketability of Clemson's MLA graduates. Students come from a range of disciplines such as planning, history, English, biology, geology, geography, environmental science, various social or natural sciences, art, or other disciplines. Application requirements are available at www.clemson.edu/caah/landscapearchitecture/

First Professional MLA

The three-year first professional degree is designed to provide students with a professional education and also an opportunity for research and/or in-depth project work. Because students hold bachelor's degrees from an array of backgrounds, it is necessary for them to gain landscape architectural skills. Those proficiency courses are also required for professional accreditation. In the first years of the program, students focus on co-requisite proficiency requirements but also take a few important graduate-level courses. More graduate-level work, project-oriented research connected to a team project and/or thesis project are emphasized during the final year. Study abroad and summer off-campus experiences are optional. Curriculum requirements are available at www.clemson.edu/caah/landscapearchitecture/

Second Professional MLA

The second professional degree in Landscape Architecture is a two-year program limited to students who hold an accredited five-year professional BLA degree. In the final semester students choose between a six-credit collaborative studio or six credits of thesis work. Study abroad and summer off-campus experiences are optional. Curriculum requirements are available at www.clemson.edu/caah/landscapearchitecture/

PLANNING, DESIGN AND THE BUILT ENVIRONMENT

Doctor of Philosophy

The PhD Program in Planning, Design and the Built Environment is a transdisciplinary, three-year post-master's degree program consisting of 76 hours. In most cases, students enter the program with a master's degree in architecture or landscape architecture, city and regional planning, real estate development, or construction science. Because of the program's transdisciplinary orientation, students may be drawn from other disciplines including engineering, business, the social sciences, and humanities. Students from those program areas may be required to take prerequisite coursework. Students with advanced preparation may take slightly less than three years.

The curriculum is divided into five content areas as indicated below. Those content areas include core courses, concentration courses, elective courses, comprehensive examination and dissertation research. Students select a field from the traditional disciplines of architecture, landscape architecture, planning, real estate development, or construction to build disciplinary as well as a transdisciplinary area of concentration. Areas of concentration are developed subject to faculty expertise and student interest. Areas of concentration may be drawn from the program faculty's four transdisciplinary core areas: Regional and Community Development and Design; Built Environment and Health; Restoration, Sustainability and Land Ecology; and Technology, Materials, and Construction Processes. Specific research projects within in these concentrations might focus on urban design, health care, energy, development, transportation and land use, housing and community development, restoration, sustainability, architectural robotics, landscape ecology, and building practice and technology.

Core Courses—The core consists of 31 hours of coursework and includes advanced theory/history, advanced methods courses generally taken outside the college, a two-semester readings course within a disciplinary area, a contemporary issues seminar, courses in research design and teaching technique, and a colloquium. The core provides a foundation with some flexibility to tailor curriculum to individual needs within disciplinary fields of study, as well as a forum to address issues of the built environment in a transdisciplinary setting.

Concentration Courses—A student's area of concentration consists of 15 hours of coursework that may be taken within or outside the college. These courses add depth in the student's area of concentration. Students develop an individualized course of study to reflect their individual focus and career objectives. The course of study must be approved by the student's faculty advisor, committee members, and program director.

Electives—These courses add additional breadth and depth to the program. Students may add to their concentration coursework, select diverse offerings to complement the concentration, or develop a minor with nine hours in a second concentration.

Degree Plan and Comprehensive and Oral Exams—Students are assigned a program advisor upon entering the program. A program evaluation is conducted and a dissertation advisor and committee are selected at the end of the first full year of study. A curriculum plan for the remainder of the degree program is developed at that time. Comprehensive and oral examinations are administered following completion of the second full year in the program. Dissertation credit cannot be taken until comprehensive exams are scheduled.

Dissertation Research—Students develop a dissertation in their area of concentration. A minimum of 24 hours in dissertation research is required.

PROFESSIONAL COMMUNICATION

Master of Arts

The Department of English offers an interdisciplinary Master of Arts degree in Professional Communication which combines work in theory and research with a comprehensive emphasis on written, oral and visual communication. It prepares graduate students to be professional and technical communicators in industry and government and to be teachers of professional communication in two-year colleges. In addition, the program provides the background necessary for students who plan to pursue a PhD 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 Multimedia Authoring Teaching and Research Facility and the Class of 1941 Studio for Student Communication give MAPC students access to corporate-style presentation and collaboration space as well as the newest computing hardware and software, enabling multimedia and Web design and production, digital video and audio editing, desktop publishing, and graphic design. Clemson's award-winning undergraduate writing programs and faculty with expertise in the teaching of writing allow MAPC students to work at the forefront of innovative writing pedagogy. 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 Usability Testing Facility allows students to conduct state-of-the-art usability research on interface designs, on-line documentation and other publications. MAPC students wishing to pursue careers in the growing field of health communication also have the option of combining the Master's degree with the Health Communication Certificate program described below.

Additional information about the MAPC program is available at www.clemson.edu/caah/mapc/.

Admission Requirements

Applicants must hold a degree in any field from an accredited college or university, with a 3.0 grade-point ratio on a 4.0 scale; submit a satisfactory score on the GRE general test; submit at least two letters of recommendation from individuals familiar with the candidate's academic work and/or work experience; and submit a brief résumé, a one-page statement of purpose discussing why the candidate wishes to pursue the MAPC degree and ten pages of workplace or academic writing.

Requirements for Awarding of a Degree

The MA in Professional Communication requires 30 credit hours beyond the BA or BS degree, distributed as follows:

- Four core courses—ENGL 850, 852, 853; and ENGL 856 or COMM 664.
- Five electives in a specialty area chosen to meet professional goals. Possible electives include professional communication courses in writing, teaching, digital publishing and corporate communication, as well as courses in related disciplines.
- Candidates must demonstrate a reading knowledge of a foreign language and pass a qualifying examination on a reading list.
- ENGL 892—In this three-credit course, students complete a portfolio, the main component of which is a semester-long, potentially publishable paper; or a client project accepted by the client and approved by the student's Portfolio Committee, which is comprised of three MAPC faculty. This requirement includes (a) the article or client project; (b) a multimodal introduction offering a defense of the paper or project; and (c) a formal presentation to the Portfolio Committee.

Health Communication Certificate

An interdisciplinary Certificate in Health Communication is also available to students in the MAPC degree program and to practicing health professionals who already have graduate degrees or are pursuing graduate degrees in Nursing, Health Sciences and many other fields. This 18-credit-hour certificate program offers students the ability to develop careers in writing for the pharmaceutical, scientific, medical and/or health industries. It especially targets jobs in hospital systems, HMOs, clinics, CDC and other local, national and international health organizations. The certificate program is available through two tracks:

- MAPC students who specialize in this field by taking ENGL (COMM) 804, 806, and (COMM) 807 to fulfill their MAPC program cognate requirements
- Health professionals who need to update their communication skills to better meet the challenges of today's highly technological health settings

Unlike other programs in health communication, this program is geared toward the technological skills more applicable to today's health industry. In addition, the program can be customized to individual student needs, whether they be centered on technological skills available through the MAPC/HCC program or targeted for those who already have technical skills in health content and/or medical humanities. This program is interdisciplinary and includes both arts and sciences approaches to health messaging. Additional information is available at www.clemson.edu/caah/healthcomm/.

REAL ESTATE DEVELOPMENT

Master of Real Estate Development

The full-time, 54-credit, two-year professional Master of Real Estate Development (MRED) degree program is jointly offered by the Department of Planning and Landscape Architecture and the School of Accountancy and Finance in the College of Business and Behavioral Science. Required courses are drawn from six disciplines: MBA, finance, law, architecture, construction science and management, and planning and landscape architecture.

A two-week South Carolina Coastal Real Estate Development Field Tour is required during the summer. Students study developments in Myrtle Beach, Pawleys Island, Charleston, Beaufort and Hilton Head prior to the required ten-week supervised professional summer internship. Other regional field trips occur in Charlotte, Atlanta and nearby areas.

The program creates the educational opportunity for future development entrepreneurs to produce exciting, quality projects respecting environmental and economic sustainability, social consciousness, design excellence and financial feasibility within the risk-reward framework. The development industry is complex and requires leaders trained from diverse disciplinary perspectives. The program primarily follows the principles of the Urban Land Institute (ULI), which acknowledges that development is a public-private partnership and that quality development requires integrating the perspectives of community, environment and economics.

Some first-year students will obtain research analyst positions for ten hours per week, assisting professors in research at the Richard H. Pennell Center for Real Estate Development. Second-year MRED students may work two days each week during the academic year at paid internships with local real estate entities. Positions typically require interns to have transportation throughout the metro area (up to a 60-mile radius). The program requires a 10-week summer internship with a real estate business anywhere in the world.

The program seeks an interdisciplinary student body that is entrepreneurial yet team-oriented. No specific bachelor's degree is required. Work experience is not required, although it is preferred.

The program focuses on the "master builder" concept, the methodology promoting an entire vision for a community through sustainable design, creative financing, place-making and healthy communities. A graduate will become a visionary who serves as a craftsperson and designer of neighborhoods and community development, one who recognizes the role of the developer in guiding the different aspects of creating the built environment—political, economic, physical, environmental, legal and sociological parameters.

Additional information is available at CURealEstateL@clemson.edu or at www.clemson.edu/mred

Course Requirements

The Master of Real Estate Development Program requires a minimum of 54 credit hours (60 credits for students with no previous degree background and previous coursework in the field). Additional electives are based on class exemptions dependent on prior coursework.

Following is the required curriculum for students with no undergraduate background in the field:

First Year

First Semester

3 - C R P 800 Human Settlement
3 - C R P 802 Site Planning and Infrastructure
3 - M B A 819 Intro. to Accounting and Finance (for non-business degree majors)
3 - M B A (FIN) 836 Real Estate Principles
3 - RED 800 Real Estate Development Process

15

Second Semester

3 - ARCH 820 Building Design and Construction Principles
3 - M B A 841 Real Estate Finance
3 - RED 801 Real Estate Market Analysis
3 - RED 804 Practicum in Residential Development
1 - RED 810 Real Estate Seminar Roundtable
2 - RED 812 Real Estate Technology

15

Summer Sessions

3 - RED 802 Real Estate Dev. Field Tour Seminar
3 - RED 811 Summer Internship in Real Estate Development

6

Second Year

First Semester

3 - C S M 866 Contractor Role in Development
3 - LAW 848 Law for Real Estate Professionals
3 - M B A 833 Real Estate Investments
3 - M B A 842 Real Estate Valuation
3 - RED 803 Public-Private Partnership Dev.

15

Second Semester

3 - RED 805 Practicum in Commercial Dev.
3 - RED 813 Real Estate Develop. Strategic Planning
3 - Elective

9

RHETORICS, COMMUNICATION AND INFORMATION DESIGN

Doctor of Philosophy

The PhD program in Rhetorics, Communication and Information Design features an interdisciplinary curriculum developed by faculty from Art, Communication Studies and English. The curriculum provides a solid foundation in theory in addition to extensive training in research and practice.

Admission Requirements

Students admitted to the PhD program in Rhetorics, Communication and Information Design must meet the following minimum requirements:

1. Minimum combined score of 1000 on the two objective sections (verbal and quantitative) of the Graduate Record Examination (GRE) and a minimum score of 4 on the analytical writing section. (GRE scores more than five years old relative to the date of initial enrollment will not be accepted.) Because of the strong communication component of the PhD program, non-native speakers of English must have a minimum TOEFL score of 550 (paper version) or 213 (computer version) in addition to the GRE scores.
2. Master's degree in Communication Studies, English, Art, Professional Communication, or other related field. A student with a master's degree in another field of study may apply to the program with the understanding that he/she may be required to complete prerequisite, master's-level courses in professional communication prior to full admission to the PhD program.
3. Minimum grade-point ratio of 3.5 in previous graduate work. The student must submit all transcripts of previous graduate and undergraduate work.
4. International students seeking graduate teaching assistantships, whose native language is not English and whose secondary education (and beyond) was not taught fully in English, must pass the SPEAK test of proficiency in spoken English. Specialists in English as a Second Language administer this test at Clemson. Prospective international teaching assistants will also undergo an interview during which their proficiency in spoken English will be evaluated by faculty members in the RCID program.

In addition, the student must submit the following:

1. Portfolio of previous graduate work, including a writing sample, preferably a sole-authored paper submitted in a graduate class
2. Personal statement addressing the student's interest and intent in pursuing the PhD in Rhetorics, Communication and Information Design
3. Minimum of three letters of reference from academic sources
4. Completed application for admission

Program Requirements

Candidates for the PhD degree must complete 36 hours of graduate credit, including five required core courses (RCID 801, 802, 803, 804, 805), five cognate courses in a specialization and six credit hours of studio research or applied project work (RCID 880). Candidates must also pass a comprehensive exam and write a dissertation.

VISUAL ARTS

Master of Fine Arts

The Master of Fine Arts degree is the terminal degree in the visual arts. Clemson University's program offers concentrations in the studio areas of drawing, painting, printmaking, ceramics, photography and sculpture. Interdisciplinary and collaborative projects are encouraged within the department. The primary goal of the program is to provide students opportunities to develop a high degree of professional competence in their chosen area of concentration.

Admission Requirements

The Master of Fine Arts degree program in Visual Arts admits a limited number of talented and creative candidates on a competitive basis upon review of the following materials:

1. Bachelor's degree from an accredited college or university with a major in Visual Arts. Especially well-qualified persons from other disciplines or degree backgrounds with exceptionally strong portfolios may be accepted.
2. Minimum grade-point ratio of 3.0 on the last 60 major credit hours of undergraduate work
3. Portfolio documentation of the applicant's creative work. The portfolio should include 15 to 20 works, the majority of which represent the applicant's chosen field of study. The portfolio should consist of 20 images and an accompanying list identifying each image and indicating the size of the work and the media used. CDs with images in JPEG or PDF format are preferred. PowerPoint documents are not accepted. The portfolio is reviewed by the Admissions Committee, composed of members of the faculty of the Department of Art. Applicants are also encouraged to arrange for a campus interview before or during the application process.
4. Three letters of recommendation from major professors, producing artists, or professional acquaintances who are familiar with the applicant's work and development in the visual arts

5. A one to two-page artist statement that provides insight into the development of the work completed to date. The statement should address ideas relative to form and content.

6. Statement of intent regarding applicant's interest in pursuing the graduate degree

7. No GRE is required.

Requirements for Degree Candidacy

The prospective candidate must have a review of his/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 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

1. A minimum of 45 credit hours with a *B* average or better in the student's professional curriculum, including 36 hours of ART 600- and 800-level studio courses and nine hours of AAH 600- and 800-level Art History courses.

2. A 15-credit-hour thesis culminating in satisfactory completion of a written documentary of the "thesis exhibition" and an oral examination by the graduate faculty

2012-13

COLLEGE OF BUSINESS AND BEHAVIORAL SCIENCE

The mission of the College of Business and Behavioral Science is to develop leaders through education and research focused on human behavior and business practices in organizations, economies and societies.

The College of Business and Behavioral Science offers advanced degrees in Accounting, Applied Economics, Applied Economics and Statistics, Applied Psychology, Applied Sociology, Business Administration, Economics, Graphic Communications, Human Factors Psychology, Industrial/Organizational Psychology, Management, and Marketing. The Master of Real Estate Development is offered in cooperation with the College of Architecture, Arts and Humanities.

Courses are also offered in entrepreneurship, finance, law, marketing and political science to provide program requirements and electives for students in other areas.

The graduate programs in the College of Business and Behavioral Science provide a wide range of opportunities for academic careers and for professional careers in business, industry, government and nongovernment public sector organizations. Degrees offered in the business disciplines are fully accredited by the Association to Advance Collegiate Schools of Business (AACSB).

In the MA, MS and PhD programs, extensive research programs involve graduate students in both theoretical and applied research and provide excellent opportunities for thesis and dissertation research. The professional master's degree programs feature assistantships and internships that provide opportunities for practical experience in the student's field. Financial aid, in the form of fellowships and teaching and research assistantships, is available for full-time participants in all graduate programs.

In addition to a full range of graduate programs offered on the main Clemson campus, some degree programs may be completed via off-campus evening course offerings. The Master of Business Administration (MBA) degree is offered at the University Center of Clemson at the Falls campus in Greenville.

Additional information is available at cbbs.clemson.edu.

ACCOUNTING

Master of Professional Accountancy

The Master of Professional Accountancy (MPAcc) degree program prepares students to begin careers in public accounting or further graduate study. The program requires 30 credit hours and ACCT 856, 857, 858, and 859 and is open to students with appropriate backgrounds. The program accommodates full- and part-time students. Full-time students are able to complete the program in one year.

The MPAcc program recognizes the evolution of the theory and practice of financial reporting, auditing and taxation, technological advances in managing data and increases in the volume and scope of authoritative pronouncements from the FASB, IASB, SEC and IRS. Two specializations are available: Assurance Services and Taxation. The program is accredited by AACSB, International.

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 Finance. 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 credit hours, as well as the following accounting prerequisites: intermediate accounting (at least six credit hours), cost accounting (three credit hours), individual income tax (three credit hours), auditing (three credit hours), and accounting information systems (three credit hours). Current information is available at business.clemson.edu/Account/.

APPLIED SOCIOLOGY

Master of Science

The Department of Sociology and Anthropology offers the MS 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; must have completed a minimum of 15 undergraduate credit hours in sociology or another social science discipline that includes at least one course each in statistics, research methods and sociological theory; must submit GRE scores on the verbal, quantitative and written sections (satisfactory scores normally include a minimum of 500 on the verbal and quantitative sections of the test and a 4.0 on the written section); must submit three letters of recommendation, at least two of which are from faculty members of the applicant's previously attended college or university; and must 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 credit hours of coursework, including SOC 803, 805, 807, 810, 830, 895, and either ANTH 603 or SOC (R S) 671. 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 choosing the nonthesis option must complete 40 hours of coursework, including SOC 803, 805, 807, 810, 830, 895, and either ANTH 603 or SOC (R S) 671. In addition, students selecting the nonthesis option must pass a departmentally administered comprehensive examination. Students must demonstrate competence in basic statistics by passing a departmentally administered competency examination or by earning a *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 years of the program, but only after completing a minimum of 12 credit hours of 800-level coursework. In exceptional circumstances, the graduate coordinator may approve the substitution of six hours of appropriate coursework for the field placement when the student has had work experience comparable to the placement.

BUSINESS ADMINISTRATION

Master of Business Administration

The Master of Business Administration (MBA) program provides an in-depth approach to business education, with opportunities to engage in real-world projects, interact with the business community, and participate in an extensive network of professional development activities. As is typical of MBA programs, the Clemson MBA is designed for students with a minimum of two years of post-undergraduate professional work experience. Some exceptions to the work experience standard are made for outstanding students with non-business undergraduate degrees, particularly those pursuing another graduate or "dual" degree at Clemson.

The MBA program provides a flexible, high quality experience designed to prepare graduates for successful management careers in business. The academic program is a maximum of 55 credit hours (roughly 21 courses) for those with little work experience and no prior business education; and a minimum of 36 credit hours (about 14 courses) for those with significant work experience and prior education in business. Students may pursue the MBA full-time (roughly 12 credit hours per semester) or part-time (three-six credit hours per semester) in the evenings. The MBA program is offered at the Clemson at the Falls campus in Greenville.

The MBA program includes foundation, core, elective and internship courses. The foundation and core courses provide in-depth coverage for the basic business functions, as well as communications, ethics and leadership. Additionally students are required to complete nine hours of approved graduate electives. Full-time students are encouraged to participate in internships or in one of many international study-abroad options during the summer.

Admission is based on standardized test scores (GMAT, TOEFL for applicants whose native language is not English), two letters of recommendation, academic background (transcripts), work experiences (resume) and an interview. For more information about the admissions process or program specifics, including dual degree opportunities, please visit www.clemson.edu/mba.

Entrepreneurship and Innovation Concentration

The Master of Business Administration Entrepreneurship and Innovation Concentration complements the existing MBA degree program and is aimed at individuals seeking business training directed toward new business creation. This concentration area is designed for working professionals seeking to realize their emerging business dreams; existing owners of start-up companies seeking to expand their entrepreneurial knowledge; and recent graduates of universities who have decided not to pursue initial careers in corporate settings.

The Entrepreneurship and Innovation Concentration within the MBA program includes 36 hours of coursework. The coursework covers topics such as Entrepreneurial Mindset, Building Business Insights, Advanced Business Learning as well as a business seed competition for all students enrolled in the program. During the course of the program students receive help from experienced entrepreneurial mentors, create a business plan, register and/or incorporate a business and create and launch a company Web site and social media presence. The final project is a business plan competition for \$25,000 of seed capital.

Admission is based on students' academic background, standardized test scores (GMAT, TOEFL for applicants whose native language is not English), business idea presentation, work experience (résumé), and letters of recommendation. For more information regarding the admissions process or program specifics, please visit www.clemson.edu/mba.

ECONOMICS

Master of Arts

Master of Science

Doctor of Philosophy

The Department of Economics offers PhD degrees in Economics and Applied Economics, a Master of Arts in Economics, and a Master of Science in Applied Economics and Statistics. In addition, excellent undergraduate students can enroll in the BA/MA program in Economics, in which up to twelve hours of graduate courses can be applied to both the undergraduate and MA degrees in Economics. Detailed program information is available at <http://economics.clemson.edu/graduate-program>.

Master of Arts

Applicants to the MA degree program must have completed at least 12 credit hours of undergraduate economics, including a course in intermediate microeconomic (price) theory. A background in mathematics, including at least one course each in calculus and statistics, is also required. When necessary, the economic theory, mathematics, and statistics courses may be taken at Clemson University.

The graduate program includes 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 are offered.

Students pursuing a terminal MA degree must complete 24 credit hours of coursework, six credit hours of thesis research, and submit an approved thesis. PhD students continuing beyond the first year may receive an MA degree upon the completion of the PhD core courses with at least a B average. With the permission of the graduate coordinator, a maximum of six hours of course credit may be earned for graduate courses taken at Clemson outside the Department of Economics. All remaining courses must be taken within the Department.

Combined BA/MA in Economics

The BA/MA program allows students to count up to 12 hours of graduate credit toward both the bachelor's and master's degrees. Students participating in this program must major in either the BA or BS in Economics, have a minimum cumulative grade-point ratio of 3.4, and be admitted to the Graduate School prior to registering for graduate courses. Details of the suggested curriculum and program information are available from the Department of Economics. Application details are available in the *Undergraduate Announcements*.

Master of Science

The MS in Applied Economics and Statistics provides training in applied economic theory, econometrics, environmental, and statistical methods for business and government decision making. The substantive focus is agricultural or environmental business, economic development, natural resource management, and government policies. The methodological focus is econometrics, spatial and ecological statistics, and statistical techniques for data analysis and the design of research and surveys.

The MS curriculum has a thesis option and a non-thesis option. The thesis option is designed for individuals who plan to pursue a Ph.D. degree or a career that requires a high level of research competence. The thesis option requires 24 semester hours of course work and 6 credit hours of thesis research. The non-thesis option is designed for individuals who want technical skills for their professional careers in business or government. The non-thesis option requires 30 semester hours of course work.

The MS degree is officially recognized for participants in the Peace Corps Masters International program. Participants in this program can choose the thesis or non-thesis option, and may earn up to six credit hours in conjunction with their Peace Corps service.

Doctor of Philosophy

The PhD program in Economics develops students who are well-trained in economic theory and its empirical application to research in a variety of fields. Applicants to the program should have a strong background in economic theory and statistics. The PhD in Economics requires 60 hours of coursework, including 18 dissertation hours. Demonstration of competence by passing core course sequences in the

initial year of study and subsequent qualifying exams in economic theory and econometrics is required. Students choose two concentrations from among the fields of economic growth and development, environmental economics, financial economics, industrial organization, labor economics, monetary economics, public economics, and others supported by departments across the University. Coursework in these fields is generally undertaken in the second and third years of study, with the goal of developing a significant research program leading to successful completion of the dissertation within four or five years. Faculty in the department are also responsible for the PhD program in Applied Economics. Fields in agricultural economics, environmental and natural resource economics, and applied statistics are offered in this program.

GRAPHIC COMMUNICATIONS

Master of Science

The Master of Science in Graphic Communications degree program prepares students for technical, creative, or professional careers in graphic communications, the third largest manufacturing industry in the United States. The 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 science, communications, technology and various business fields who want to transition into graphic communications fields.

The MS program is enhanced by Clemson's undergraduate program of more than 400 students and works closely with Clemson's nationally recognized Packaging Science program. Industry supports well-equipped G C laboratories. Graduates 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. Placement rates are consistently high.

Program entrance is available fall, spring and first or second summer terms. Requirements for the program include 33 credit 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 G C technical/managerial courses; seven will be research related; six credits will be from outside the Graphic Communications Department; and at least one-half will be at or above the 800 level. Based upon applicant's undergraduate coursework and work experience, 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, the Graphic Communications 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 MS in Graphic Communications program relates to the applicant's professional goals. A separate résumé should accompany the narrative.

MANAGEMENT

Master of Science

Doctor of Philosophy

Master of Science

The Master of Science in Management (MSM) program prepares professionals to be effective leaders in supply chain, innovation, and information technology management. Graduates will have the advanced technical, entrepreneurial, and leadership skills necessary to succeed as mid- or upper-level managers in manufacturing, service, and consulting organizations. The MSM program also prepares qualified students for further doctoral study in the fields of supply chain and operations management, as well as information systems management. MSM students benefit immensely from the focused curriculum, close coordination of courses with the Master of Business Administration (MBA) program, and small class sizes.

The program requires a business discipline undergraduate or graduate degree. The MSM curriculum requires 30 credit hours, which include seven core management discipline courses, consisting of Information Systems, Managerial Decision Modeling, Operations Management, Organizational Behavior/Human Resources Management, Project Management, Statistical Analysis of Business Operations, and Strategic Management. A thesis or comprehensive final examination is required once all coursework has been completed. Core and elective courses cover a broad range of topics in supply chain and information technology management and in entrepreneurship and innovation management. The Graduate Programs Committee will approve the final program for each student based on his/her background, interests and availability of courses. Students can complete the program in ten months; however, there are a limited number of graduate courses offered by the Department of Management during summer sessions. Students may elect to take an independent study or directed readings course within their area of interest.

MSM courses are offered in Greenville, although students may also take courses offered on the main Clemson campus. All MSM students have high-speed access to the Internet and campus-wide networks containing the latest business applications. The Department of Management has a dedicated Enterprise Management Laboratory that provides access to industrial manufacturing resource planning software. The mission of the laboratory is to promote operations management by attracting talented students to the field and uniquely preparing them for career challenges in the profession. This is accomplished through active learning involving modern principles of manufacturing management, leading-edge enterprise resource planning software, teamwork, and leadership.

Dual master's degree opportunities (pursuing MSM and MBA degrees simultaneously) are available to interested and qualified students. To earn a dual degree, students must be admitted into both programs. Up to one-sixth of the total number of credit hours taken may be counted toward both degrees. If a student takes classes full-time, typically both degrees can be earned in approximately two and a half years.

Combined BS/MS in Management

Undergraduate Management majors at Clemson University may begin a Master of Science (MS) degree in Management while completing their Bachelor of Science (BS) degree requirements. The BS in Management degree allows up to 12 credits of mutually acceptable graduate course credits to satisfy requirements for both degrees. Students participating in this program must have a minimum undergraduate grade-point ratio of 3.4, have completed at least 90 credits, and be admitted to the Graduate School prior to registering for graduate courses. Students in the combined degree program are conditionally accepted to the graduate program until completion of the BS degree requirements.

Doctor of Philosophy

The PhD program in Management is designed to provide advanced education for students of outstanding ability who desire to pursue careers in academic research institutions. The coursework for the PhD in Management includes a rigorous set of intellectually stimulating and challenging scholarly methods, foundation, and advanced courses and seminars. In addition, the program requires successful passage of a comprehensive examination and successful completion of the doctoral dissertation. A variety of learning experiences are incorporated into the curriculum, including the development of conceptual frameworks and theories, qualitative case and empirical studies, field projects, and in-depth research. Before graduating, each student will (1) have presented, or had accepted for presentation, a paper before a professional or scientific society; or (2) have had an article published, or accepted for publication, in a refereed journal. In addition, each student will have classroom teaching experience.

Within the Department of Management, PhD students have tremendous opportunities to conduct cross-disciplinary research between supply chain and operations management and information systems or with high-quality faculty in entrepreneurship and strategic management, as well as organizational behavior and human resources management. The goal is to position graduates for scholarly academic careers at colleges and universities throughout the United States and the world.

The PhD program in Management is designed for full-time students who remain on-campus during the entire duration of their study. Students may enter the program in the fall semester only (starting mid-August). Students with bachelor's or master's degrees in a business discipline can typically complete the program in four calendar years. Students with non-business degrees will need to complete background courses that may lengthen the program duration. Students entering the program must have completed undergraduate and/or graduate coursework in calculus and linear algebra.

MARKETING

Master of Science

The Master of Science in Marketing degree program advances students' knowledge and expertise in marketing theory and practice and prepares them for careers in marketing analysis, research, management and scholarship. A coordinated curriculum of quantitative and analytical skills development, research methods, consumer analysis and strategic marketing analysis provides students with the necessary background to pursue careers in marketing research, analysis and policy and/or as a platform for further education to prepare students for careers in academe. This is accomplished through rigorous coursework and seminars and a major research project. This one-year master's degree is designed to enhance the skills and training of students with prior academic and work experience in business. Applicants should have an undergraduate degree in business from an accredited college or university. In addition, it is preferred that incoming students have some professional work experience. Students applying to the MS in Marketing program who are not graduates of an AACSB-accredited college or school of business administration will be required to demonstrate completion of three credit hours of collegiate microeconomics, six hours of calculus and a junior-level course in marketing, or equivalent, to be considered for the program.

The Master of Science in Marketing degree requires completion of 30 credit hours of graduate marketing and related coursework. Core classes include EX ST 801, MKT 860, 861, 862, 863, 865, 870. In addition, three credit hours in approved graduate coursework and three hours in advanced topics in marketing are required. MS in Marketing courses are typically offered at Clemson at the Falls campus in Greenville, although students may also take courses on the main Clemson campus.

MBA

See Business Administration heading.

PSYCHOLOGY

The Department of Psychology offers PhD degrees in Industrial/Organizational Psychology and in Human Factors (Engineering) Psychology and an MS 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 Human Factors Concentration is fully accredited by the Human Factors and Ergonomics Society.

APPLIED PSYCHOLOGY

Master of Science

HUMAN FACTORS PSYCHOLOGY

Doctor of Philosophy

INDUSTRIAL/ ORGANIZATIONAL PSYCHOLOGY

Doctor of Philosophy

Information regarding Psychology Degrees

A formal thesis and supervised field internship are required for the MS degree. MS students complete 45 credit hours, including six hours of thesis credit and six hours of credit for the internship. Typically, the internship is completed in the summer between the first and second years of the program. In some cases, six credit hours of approved electives may be substituted for the field internship.

Students in the doctoral programs are expected to satisfy the master's program requirements plus an additional 45 credit hours prior to receiving the doctorate. In addition to the required courses, a doctoral program must include 18 hours of dissertation research and an oral dissertation defense. Students are admitted to candidacy for the PhD degree upon successful completion of a comprehensive examination.

Applicants should have an undergraduate degree with a major in psychology or a related field from an accredited college or university. All applicants must submit scores from the general portion of the GRE. Applicants must also submit three letters of reference and a statement describing their interests and accomplishments and the faculty members they want to work with. The application deadline is January 15. Program information and application requirements are available at www.clemson.edu/psych/.

REAL ESTATE DEVELOPMENT

Master of Real Estate Development

The Master of Real Estate Development Program, jointly administered by the School of Accountancy and Finance and the Department of Planning and Landscape Architecture in the College of Architecture, Arts and Humanities, creates the educational opportunity for encouraging future development entrepreneurs to produce exciting, quality projects respecting environmental sustainability, social consciousness, design excellence and financial feasibility within the risk-reward framework. See complete program description under the College of Architecture, Arts and Humanities.

TECHNOLOGY ENTREPRENEURSHIP

Certificate

The Certificate in Technology Entrepreneurship is available to graduate students in engineering and science disciplines across campus. The certificate is intended to serve those students who envision an entrepreneurial career as their long-range career goal, who want to be involved in new product and new business activities within a corporate setting, or who seek a better understanding of the process of commercializing inventions.

The program requires E L E 600, 800, and one of the following: an additional section of E L E 800, M B A (MGT) 845, or M B A 875.

2012-13

COLLEGE OF ENGINEERING AND SCIENCE

The College of Engineering and Science offers advanced degrees in Automotive Engineering, Bioengineering, Biosystems Engineering, Chemical Engineering, Chemistry, Civil Engineering, Computer Engineering, Computer Science, Digital Production Arts, Electrical Engineering, Environmental Engineering and Science, Human Centered Computing, Hydrogeology, Industrial Engineering, Materials Science and Engineering, Mathematical Sciences, Mechanical Engineering, Photonic Science and Technology, and Physics.

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. The MS and PhD 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 opportunities for thesis and dissertation research.

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.

Graduate engineering education opportunities for practicing engineers are available in two disciplines. The Department of Electrical and Computer Engineering offers off-campus graduate courses leading to the Master of Engineering degree through satellite broadcasts, Internet and DVD. The Department of Mechanical Engineering offers selected off-campus graduate courses at the University Center of Greenville. Furthermore, graduate courses in both disciplines are offered on-campus during the late afternoon/early evening once a week.

AUTOMOTIVE ENGINEERING

Master of Science

Doctor of Philosophy

The Master of Science and Doctor of Philosophy degrees in Automotive Engineering prepare a new generation of engineers to deal with the complex technological, environmental and globalization issues facing the automobile industry.

The big challenge facing the industry is the integration of diverse technologies in the automobile and its cost effective and environmentally responsible manufacture, all being done in a global network with people of different backgrounds and cultures. The Automotive Engineering programs equip students with the basis, depth and domain knowledge needed for master's and doctoral-level expertise in systems integration and vehicle systems engineering and the ability to work globally. Graduates of the program are able to lead teams of culturally diverse individuals to produce an integrated automobile platform or to work in research laboratories involved with the design of new products in the automotive field. While the program is geared toward the automobile industry, it produces strong linkages with the aerospace and other industries within the state, region and nation as some of the challenges faced by the automotive industry are also faced in other sectors.

Master of Science

Admission to the MS program occurs in the fall semester only. Students are required to hold a BS degree from a recognized relevant engineering or science discipline and the equivalent of two years of postbaccalaureate full-time work experience in industry. Students have the opportunity to tailor the program either in the functional aspects or systems aspects of automotive engineering through appropriate course choices.

The program is divided into four content areas, consisting of 36 credit hours of coursework and six hours of project work, as follows:

Core Courses—AU E 880, 881, 882, 883

Automotive Engineering Track—18 credit hours in two or three track areas with nine hours in automotive engineering courses and nine hours based on the student's interests and specialization.

Business or Related Field—a minimum of six hours in a concentration area or minor approved by the advisory committee

Internship—a six-credit-hour internship of six months duration in an industrial setting

Foreign language proficiency is required as an outcome of the program.

Doctor of Philosophy

Students are admitted into the PhD program in the fall, spring and summer terms. Minimum admission requirements include a bachelor's or master's degree in a recognized relevant engineering or science discipline. Students entering the program directly with a BS degree must meet the entrance requirements for the MS degree and have a grade-point ratio of 3.5 or higher in their undergraduate programs. Students with an MS degree in a recognized relevant engineering or science discipline are not subject to the two years of postbaccalaureate full-time industrial experience requirement.

Program requirements are as follows:

Core Courses—AU E 880, 881, 882

Automotive Engineering Track—minimum of six hours (two AU E courses from two track areas)

Discipline-Specific Courses—no minimum requirements, typically five additional courses

Business or Related Field—minimum of three hours in a directed, nontechnical field

Technical Courses—minimum of nine hours in a concentration area outside the discipline or a technical minor

Dissertation—18 credit hours

Foreign Residency Requirement—six-month residency at a foreign research laboratory or university

BIOENGINEERING

Master of Science

Doctor of Philosophy

Bioengineering is the application of engineering and scientific principles to understand and solve medical problems. As medical technology has rapidly developed over the past four decades, the demand for qualified bioengineers has dramatically increased. Career opportunities for bioengineers range from teaching and conducting basic research in academia to research and development work in the growing medical product industry. Employment opportunities are also available in independent research laboratories, hospitals and federal agencies such as the Food and Drug Administration or the National Institutes of Health.

Applicants to the Bioengineering programs typically hold a Bachelor of Science degree in engineering or applied science. Students with nonengineering backgrounds are required to take remedial courses in engineering (e.g. materials science, statics and mechanics, and calculus through differential equations) in addition to their regular bioengineering curriculum, which may be taken either before or after enrollment.

The Department offers a Master of Science and a Doctor of Philosophy degree. The curriculum for the MS degree consists of a core of recommended bioengineering courses supplemented by elective courses that provide the student greater depth in a specific area of interest. Two degree options are offered at the master's degree level: a thesis and a nonthesis option. The thesis option requires a total of 30 credit

hours (six of which must be research credits) and the submission and defense of a master's thesis. The nonthesis option requires a minimum of 33 credit hours followed by the submission and oral presentation of a publishable-quality report on an approved topic. The minimum time necessary to complete the master's degree is normally 16 months, out of which at least one academic semester must be undertaken in residence as a full-time student at Clemson University.

Students interested in obtaining a doctoral degree are encouraged to apply directly to the PhD program from their BS degree program, with the PhD program typically requiring about five years to complete following the BS degree or about four years following the MS degree. The selection of courses for the doctoral degree is flexible and depends on the background and objectives of each candidate. A typical program includes 12 or more credit hours of graduate-level courses beyond the MS degree requirements. Candidates for the PhD degree must provide evidence of their potential success in advanced graduate study. This is demonstrated by passing the candidacy exam. The PhD program culminates with the presentation and successful defense of a doctoral dissertation, which is scheduled following the completion of the student's approved research plan. More detailed information is available in the website: <http://www.clemson.edu/ces/bioe/>

Combined BS/MS Plans

The Department of Bioengineering offers a combined BS/MS plan. Under the plan, students may reduce the time necessary to earn both a BS degree in Bioengineering or Biological Sciences and an MS in Bioengineering by applying graduate credits to both undergraduate and graduate program requirements.

Students are encouraged to obtain the specific requirements for the dual degree from the undergraduate department or the Department of Bioengineering as early as possible in their undergraduate programs to ensure that all prerequisite and other program requirements are met. Enrollment guidelines and procedures can be found in the website: <http://www.clemson.edu/ces/bioe/>

BIOSYSTEMS ENGINEERING

Master of Science

Doctor of Philosophy

The biosystems engineering graduate program within the EEEES department is designed to prepare graduates for leadership, creative accomplishment and continued professional learning, and to prepare graduates to effectively conduct independent scientific research related to sustainable biological systems design.

Students from all engineering disciplines are encouraged to apply. Applicants from non-engineering disciplines are welcome, but may be required to take additional undergraduate courses. 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 including bioprocessing and ecological engineering. In addition to biosystems engineering, course work

includes mathematics, physics, chemistry, statistics, and biological and engineering sciences.

Graduates from the BE program find employment in biofuels, biopharmaceutical and bioprocessing plants or biorefineries, engineering and environmental consulting firms, sustainable land and water resource management, state and federal government agencies, and academia.

For admission to the M.S. or Ph.D. program, an applicant should have a grade point ratio/average (GPR/GPA) of at least 3.0 out of 4.0. Ranges of scores for students admitted to the BE program on the Graduate Record Exam (GRE) are typically greater than 155 (700) Q, 150 (450) V, 3.5 A and 90 TOEFL. Students with a baccalaureate or masters degree in a related science or engineering field may apply directly to the PhD program. Students with exceptional records and experience in research will be considered for the PhD degree without a master's degree, while most students admitted to the PhD program will have previously received a Masters degree.

Combined BS/MS in Biosystems Engineering

Under this plan, students may reduce the time necessary to earn both degrees by applying graduate credits to both undergraduate and graduate program requirements. Students are encouraged to obtain the specific requirements for the dual degree from the Department of Biosystems Engineering as early as possible in their undergraduate program. Enrollment guidelines and procedures can be found in the *Undergraduate Announcements*.

CHEMICAL ENGINEERING

Master of Science

Doctor of Philosophy

The Department of Chemical and Biomolecular Engineering offers programs leading to the Doctor of Philosophy and the Master of Science degrees. Graduate programs at Clemson prepare students to apply science and engineering principles to complex problems associated with the chemical, biomolecular and associated industries. Students develop a rigorous fundamental science base coupled with insight into engineering applications. Graduates can become involved in the research, manufacture and use of chemicals, polymers, pharmaceuticals, electronic components, consumer products and petroleum products, to name a few. The department has strong research programs in advanced materials, biotechnology, energy, and chemical and biochemical processing.

Although most graduate students have a BS in Chemical Engineering, students with backgrounds in chemistry, physics, or other branches of engineering are encouraged to apply and will be considered fully for admission. To facilitate a transition from BS degrees other than Chemical Engineering, special programs are available. Students can enter the PhD program in Chemical Engineering directly after completion of a BS degree.

The MS degree program consists of 30 credit hours, including six credit hours of research. Coursework includes CH E 803, 804, and 805. In addition, six hours of approved chemical engineering electives and nine hours of approved technical electives are required. At least six of these 15 elective hours must be selected from courses numbered 800 or above. MS degree candidates must complete a thesis.

The PhD program consists of 30 credit hours of approved graduate courses beyond the BS degree, including six credit hours of approved graduate courses at Clemson. Admission to candidacy for the PhD degree requires completion of written qualifying and oral comprehensive examinations. Doctoral students must satisfy the MS course requirements through courses taken at Clemson University or elsewhere. In addition, each student is required to complete 30 credit hours of graduate research, including 24 doctoral dissertation research credit hours (CH E 991) taken at Clemson University. The PhD program concludes with the completion and defense of a doctoral dissertation.

Minors for doctoral students may be taken in chemistry, physics, mathematics, life sciences, or other branches of engineering.

CHEMISTRY

Master of Science

Doctor of Philosophy

Degree concentrations are offered in analytical, inorganic, organic, physical chemistry and chemistry education. Research areas also include bio-organic chemistry, polymer chemistry, materials chemistry, chemical physics and other areas. A PhD degree in Chemistry with a concentration in textile chemistry is offered jointly with the School of Materials Science and Engineering.

MS degree candidates must complete 24 hours of coursework and six hours of research culminating in a satisfactory thesis.

The primary requirement for the PhD degree is the performance of original research leading to a dissertation. PhD degree candidates must qualify to pursue the degree by completing a flexible curriculum of coursework designed to demonstrate broad chemical awareness, a distribution requirement and a focus area requirement. Some coursework requirements may also be satisfied by examination. Students must complete 18 graduate credits in their first year of study and must have a GPR of 2.90 or better by the end of their third semester.

Admission to candidacy for the PhD degree requires completion of a comprehensive examination in the area of concentration. This exam takes the form of a written cumulative exam, followed by an oral presentation before a faculty committee.

CIVIL ENGINEERING

Master of Science

Doctor of Philosophy

The Department of Civil Engineering offers graduate programs leading to the Master of Science and Doctor of Philosophy degrees. Within these degrees, there are six primary emphasis areas: Applied Fluid Mechanics, Construction Materials, Geotechnical Engineering, Project Management, Structural Engineering and Transportation Systems.

Master of Science

The Master of Science degree program is open to all individuals who have a four-year baccalaureate degree. A degree in engineering is not required for admission, but most entering students have an undergraduate Civil Engineering degree.

There are two options available for students pursuing a Master of Science degree. The student may prepare a research thesis or may take additional courses in lieu of completing a thesis.

The thesis option requires the preparation of a research thesis that is a part of the total credit hours required for the degree. Students intending to pursue a doctoral degree usually choose the thesis option. Completion of a research thesis is excellent preparation for the research necessary for a doctorate if a student is inclined to pursue that degree in the future.

The nonthesis option does not require the preparation of a research thesis but does require completion of additional coursework. This degree option provides the student with additional directed study through coursework. Normally students pursuing the nonthesis option will not pursue a doctorate.

Except for the core courses required by different disciplines, there are no formal course requirements for students pursuing a Master of Science degree. The program normally contains some engineering design and a minimum of ten credits of engineering science, advanced mathematics and basic science. In addition, each student in the thesis option must complete an advanced research project. The final program of study must contain at least 30 hours of graduate credit including the core curriculum requirements. Of these 30 credits, no more than six hours may be thesis research (C E 891) for those students pursuing the thesis option. At least half of the remaining hours must be from courses numbered 800 or above.

The final examination for the MS nonthesis option is an oral or written exam (or a combination of the two) consisting of questions related to fundamental knowledge in a student's chosen area of concentration (i.e., applied fluid mechanics, construction materials, geotechnical engineering, project management, structural engineering, or transportation systems).

The final examination for the MS thesis option is an oral exam consisting of a student's MS thesis defense and questions related to fundamental knowledge in a student's chosen area of concentration (i.e. applied fluid mechanics, construction materials, geotechnical engineering, project management, structural engineering, or transportation systems).

Doctor of Philosophy

The Doctor of Philosophy degree program is open to all individuals who have a baccalaureate degree and preferably a Master's degree in engineering. Except for the core courses required by different disciplines, there are no formal course requirements for students pursuing a PhD degree; however, each student must complete 18 hours of dissertation research (C E 991).

The purpose of the PhD research dissertation is to afford the student the opportunity to participate in independent specialized engineering research that can advance the state of the art. The research is conducted under the direction of a member of the faculty who will normally serve as chair of the student's academic advisory committee. The research should be sufficiently demanding technically so as to demonstrate the student's ability to assimilate knowledge from several subject areas for the advancement of engineering knowledge.

Student Evaluation—During the first two semesters in residence, a PhD student must select a faculty advisor. The faculty advisor may assign the student specific duties outside normal coursework requirements that include, but are not necessarily limited to, preparing research proposals and literature surveys, conducting classroom lectures, formulating computer models and executing data collection and analysis. The advisor may, at any time, withdraw as the student's faculty advisor if these assigned duties are not performed consistent with the expectations of the faculty advisor. During this initial two-semester period, an advisor should make a determination as to whether a student is capable of completing the requirements for the PhD degree.

Comprehensive Examination—The PhD comprehensive examination is generally scheduled after all coursework has been completed and the dissertation proposal is ready for approval by the student's graduate committee. The examination, therefore, consists of two parts: (1) a written and/or oral examination by the advisory committee on the student's preparation to complete the proposed research and (2) presentation of the proposed research. The PhD comprehensive examination should be completed within two years of entering the PhD program. The written and/or oral examination may include consideration of graduate coursework, preliminary research and/or other demonstration of the ability to conduct the proposed research. After passing this examination, the student is officially admitted to candidacy for the PhD degree.

Dissertation Defense—As required by the Graduate School, the candidate for the Doctor of Philosophy degree must pass a final oral examination (dissertation defense). The examination consists of a presentation of the student's doctoral research and an assessment by the committee of the research approach, the significance of the findings and the contribution to the advancement of civil engineering.

More information about the Department of Civil Engineering is available at www.ce.clemson.edu or by phone at (864) 656-3000.

Combined BS/MS in Civil Engineering

Civil Engineering undergraduates at Clemson may begin a Master of Science degree program while completing the Bachelor of Science degree and use a limited number of courses to satisfy the requirements of both their undergraduate and graduate degrees. The following requirements apply:

- Undergraduate students must have a minimum cumulative grade-point ratio of 3.4 and must have completed the junior year prior to taking graduate courses. Students are required to maintain this minimum grade-point ratio to continue enrollment in a combined degree program.
- Graduate Record Examination (GRE) scores are not required to be submitted as part of their Graduate School application; however, applicants are encouraged to submit GRE scores to receive full consideration for graduate fellowships and assistantships upon completion of the BS degree.
- Up to six semester hours from any 600- or 800-level civil engineering courses may be used to satisfy the requirements of the BS degree. These courses may be counted as technical requirements or electives. Undergraduate students are required to have selected one of their technical requirements from the area of transportation systems, geotechnical engineering, or environmental engineering.
- Since approval of the graduate program of study is required by the student's graduate advisory committee, students should consult with their academic advisors before selecting courses to be included in the graduate program.

- Students in a combined degree program are conditionally accepted to the graduate program until completion of the BS degree requirements. Students are not eligible for graduate assistantships until full acceptance is granted.

Students interested in this combined degree program should consult the Civil Engineering Graduate Program Coordinator, the undergraduate advisor and the Civil Engineering Honors Coordinator (if applicable). Students pursuing an optional emphasis area in their undergraduate degree program may substitute 600-level courses for any 400-level counterpart taken to meet the requirements of an emphasis area. Application for this program should be made by the end of the junior year, but no later than one semester prior to expected BS graduation. Application details are available in the *Undergraduate Announcements*.

COMPUTER ENGINEERING

Master of Science

Doctor of Philosophy

The Computer Engineering program is a combination of computer software, hardware, systems and applications. Areas of specialization include computer systems architecture, communication networks, digital signal processing and intelligent systems. Enrollment is open to graduates in any branch of engineering, computer science, or applied mathematics who have an appropriate engineering and/or science background.

For the MS program, students may write a thesis or follow a nonthesis option. The thesis option requires a total of 30 credit hours including six hours of thesis research. For the nonthesis option, 33 credit hours of coursework must be completed.

The PhD degree requires at least 24 credit hours of graduate coursework beyond the master's degree and 18 research credit hours. Specially qualified candidates with a BS degree may apply for direct entry to the PhD 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 60 hours including coursework and research credit.

Detailed information is available at www.clemson.edu/ces/department/ece.

COMPUTER SCIENCE

Master of Science

Doctor of Philosophy

To receive full admission to graduate study in computer science, a student must have taken intermediate-level undergraduate computer science, including computer organization, data structures, operating systems, either algorithms or theory of computation, and either compilers or survey of programming languages; and basic mathematics including discrete mathematics. An applicant with minimal deficiencies may be admitted with prerequisites, while one with several deficiencies may be required to satisfactorily complete prerequisite work as a non-degree student prior to admission as a graduate student.

A candidate for the MS degree must satisfactorily complete an approved program of at least 30 graduate hours. Students may elect one of two options to satisfy the degree requirements: a coursework-only option or a thesis option. The thesis option requires six hours of research credit as part of the 30-hour requirement. Students may take up to six hours of approved courses in areas outside the department.

Although formal course requirements for the PhD degree are minimal, a typical program requires two to four years of study beyond the MS degree. Each candidate is required to pass a comprehensive examination, a dissertation proposal and a defense of the dissertation.

Combined BS/MS in Computer Science

Computer Science undergraduates may begin a Master of Science degree program while completing the Bachelor of Science degree and use a limited number of courses to satisfy the requirements of both their undergraduate and graduate degrees. The following requirements apply:

- Undergraduate students must have a minimum cumulative grade-point ratio of 3.4 and must have completed the junior year prior to taking graduate courses. Students are required to maintain this minimum grade-point ratio to continue enrollment in a combined degree program.

- Graduate Record Examination (GRE) scores are not required to be submitted as part of the Graduate School application; however, applicants are encouraged to submit GRE scores to receive full consideration for graduate fellowships and assistantships upon completion of the BS degree.

- Students in a combined degree program are conditionally accepted to the graduate program until completion of the BS requirements. Students with this conditional acceptance are not eligible for a graduate assistantship until the conditional acceptance is removed.

- Up to nine semester hours from any 600- or 800-level computer science courses may be used to satisfy the requirements of the BS degree.

- Graduate courses taken as an undergraduate may be included in the graduate program of study; however, any 600-level course that has a corresponding required 400-level counterpart in the BS or BA in Computer Science or the BS in Computer Information Systems may not be counted toward the MS degree. Since approval of the graduate program of study is required by the student's graduate advisory committee, students should consult their academic advisors before selecting courses to be included in the graduate program.

Students interested in this combined degree program should discuss it with the Computer Science graduate program coordinator and undergraduate program advisor. Students pursuing Senior Departmental Honors should also meet with the Computer Science Honors Coordinator. Application to this program should be made by the end of the junior year but may be made at any time from the junior year until one semester prior to the expected BS graduation. Application details are available in the *Undergraduate Announcements*.

The Computer Science faculty envision students enrolled in this combined degree program will typically complete nine hours of graduate credit while completing their BS degree requirements and complete the remaining requirements for the MS degree in one calendar year or less of graduate study.

DIGITAL PRODUCTION ARTS

Master of Fine Arts

The Digital Production Arts program 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, film and gaming industries. Because the MFA is a terminal degree in fine arts, students will also be prepared to accept university faculty positions. The program is offered within the Division of Visual Computing in the School of Computing, with significant collaboration with the departments of Art and Performing Arts. It offers a unique blend of instruction, with coursework ranging from the artistic to the technical, all with a strong emphasis on advanced studio methods for visual problem solving.

The Master of Fine Arts in Digital Production Arts is administered by a supervisory board, chaired by the program director, and consisting of five additional faculty members—two from the Division of Visual Computing, two from the Department of Art, and one from the Department of Performing Arts.

Admission and Financial Aid

Applicants are required to submit GRE general test results, a portfolio of artistic work that may include slides or electronic media, and evidence of technical preparation that may include software code samples or appropriate coursework. Some assistantships may be available to especially well qualified applicants. For full consideration for admission and financial aid, applications should be received by January 10.

Requirements for Awarding of a Degree

The degree requires 60 hours, 12 of which are devoted to team-based studio work, six to individual studio work, and six to thesis preparation. This assures that students have participated in the development of several complete digital production projects, providing material for a professional quality demonstration "reel." Of the remaining 36 credit hours, 0-6 will come from foundation courses, 15 from core courses, three from aesthetic electives, and 12-18 from general electives, aesthetic electives, or core courses. Any required foundation courses are determined at the time of admission. These courses provide students with post baccalaureate work in the fundamentals of computing or the visual arts. A maximum of six hours of foundation courses may be counted towards the degree. For students with strong preparation, the course of study requires two calendar years.

Foundation Courses—Selected from D P A 600, 601 (technical), 602, 603 (artistic)

Core courses—Selected from ART 821, CP SC 604, 807, 809, 815, THEA 687

Electives—Selected from ART 605, 607, 609, 611, 613, 617, CP SC 605, 611, 614, 619, 805, 808, 819, 863, E C E 847, G C 801, MUSIC 680, PSYCH 823, THEA 672, 697.

Studios—D P A 860, 880, 891

ELECTRICAL ENGINEERING

Master of Engineering

Master of Science

Doctor of Philosophy

Students in Electrical Engineering may direct their programs toward the fields of communication systems and networks, digital signal processing, intelligent systems, applied electromagnetics, electronics, or power systems.

For the MS program, students may write a thesis or follow a nonthesis option. The thesis option requires a total of 30 credit hours, including six hours of thesis research. For the nonthesis option, 33 credit hours of coursework must be completed.

The Master of Engineering is a special degree offered for off-campus students through the University tele-campus program. Degree requirements include 24 credit hours of coursework and six hours of credit for an engineering report. Additional information is available from the Office of Off-Campus, Distance and Continuing Education.

The PhD program requires at least 24 credit hours of graduate coursework beyond the master's degree and 18 research credit hours. Specially qualified candidates with a BS degree may apply for direct entry to the PhD 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 60, including coursework and research credit.

Detailed information on program requirements and application procedures is available at www.clemson.edu/ces/department/ece.

ENGINEERING AND SCIENCE EDUCATION

Doctor of Philosophy

The PhD program in Engineering and Science Education is a nationally unique graduate program in science, technology, engineering, and mathematics (STEM) education research. The Department of Engineering and Science Education (ESE) in the College of Engineering and Science is the only department in the country that includes both engineering education and science education in a college of science and engineering. As such, it includes faculty who are experts in several areas of science education and engineering education, and who have active research programs in these fields. Students in this program are exposed to a wide breadth of STEM education research under current investigation and are prepared to interface between the development of new theory in STEM education and the implementation of new research findings in practice. This discipline-based education research (DBER) combines knowledge of teaching and learning with deep knowledge of discipline-specific science content. It describes the discipline-specific difficulties learners face and the specialized intellectual and instructional resources that can facilitate student understanding.

The objectives of the ESE PhD program are to prepare students for academic careers in STEM education, science education policy in higher education or informal education institutions, or a range of other careers that require a deep disciplinary knowledge coupled with understanding of the factors that affect student learning, retention, and inclusion in STEM. Students who enroll in this program are expected to be content experts in a STEM discipline with at least a Master's degree in their content area of expertise. Graduates from this program are prepared to become faculty in traditional departments of engineering or science, as well as STEM education departments. They are prepared to lead curricular and pedagogical reform at the post-secondary level as well as conduct research in the burgeoning fields of STEM education research.

Engineering and Science Education Certificate

The Certificate in Engineering and Science Education is designed for graduate students who want to prepare for an academic career, who wish to further their understanding of the education process in engineering and science, or who are interested in engineering and science education research. The program includes a range of courses in three main areas: Pedagogy, Professional Preparation, and Research Methods, as well as a practicum and attendance at a seminar series, for a total of 11 credits as outlined below. Additional information is available at www.clemson.edu/ese/.

Pedagogy—Three credits: CES 820 or 821 or ED 955

Professional Preparation—Three credits: CES 825, 875, or 888

Elective—Three credits: CES 871, ED F 808 or 878, EX ST 802, PSYCH 811 or 833

Practicum—One credit: CES 861

Seminar—One credit: CES 800

The PhD program provides 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 at least 30 hours of coursework beyond the MS degree in several areas of engineering and the basic sciences. Each student's curriculum and research program is tailored to suit his/her personal and professional goals. Qualifying, comprehensive and final examinations are required. No foreign language is required.

Combined BS in Biosystems Engineering/MS, MEngr in Environmental Engineering and Science

Combined BS in Environmental Engineering/MS, MEngr in Environmental Engineering and Science Undergraduate Environmental Engineering majors who have earned a grade-point ratio of 3.4 or above and completed 90 credit hours can begin work toward a Master of Science or Master of Engineering in Environmental Engineering and Science while completing a Bachelor of Science degree. The undergraduate curriculum allows up to nine credits of mutually acceptable graduate course credits to satisfy requirements of both degrees. Details are available in the Undergraduate Handbook, which can be found at www.clemson.edu/ces/ees.

Combined BS in Chemical Engineering/MS, MEngr in Environmental Engineering and Science

Undergraduate Chemical Engineering majors who have earned a grade-point ratio of 3.4 or above and completed 90 credit hours can begin work toward a Master of Science or Master of Engineering in Environmental Engineering and Science while completing a Bachelor of Science degree. The undergraduate curriculum allows up to nine credits of mutually acceptable graduate course credits to satisfy requirements of both degrees. Details are available in the ChBE Undergraduate Handbook, which can be found at www.clemson.edu/ces/chbe.

HUMAN CENTERED COMPUTING

Doctor of Philosophy

To receive full admission to graduate study in human centered computing (HCC), a student must have completed an undergraduate degree and have taken computer programming courses through data structures. An applicant with minimal deficiencies may be admitted with prerequisites, while one with several deficiencies may be required to satisfactorily complete prerequisite work as a non-degree student prior to admission as a graduate student. Although formal course requirements for the PhD degree are minimal, a typical program requires two to four years of study beyond the MS degree. Each candidate is required to pass a comprehensive examination, a dissertation proposal and a defense of the dissertation.

Admission and Financial Aid

Applicants are required to submit GRE general test results. Applicants are accepted for both fall and spring semesters. Assistantships are available for especially well qualified applicants.

Requirements for Awarding of a Degree are:

1. 60 credit hours beyond the Bachelors degree
2. A portfolio (a combined version of the PhD qualifying and comprehensive exams)
3. Competency in four topic areas, typically demonstrated by coursework: Computing, People, Research Methods and Design, Cognate Area
4. Ability to pursue research, typically demonstrated by producing a research publication, which may be co-authored with the student's advisor
5. Proposing, completing and defending a dissertation.

Students are required to have a strong computing or computation core with training in areas that emphasize people or the human condition and research methods for studying people, technology, policy and/or information. Each student is required to take a first course in the fundamentals of HCC for three hours. Students are required to take 12 hours in the computing or computer science track from 600- or 800-level computer science courses, six hours from a people or human condition track consisting of courses from psychology, human factors, policy, etc., and six hours of research methods. Students are required to take a series of at least nine hours in a cognate or specialty domain under the advisement of their dissertation research advisor with the approval of the HCC graduate program committee. Students are also required to take six hours of pre-dissertation (pre-portfolio) research, CP SC 888 Directed Projects in Computing. Students also take 18 hours of dissertation research (CP SC 991).

HYDROGEOLOGY**Master of Science**

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 Environmental Engineering and Earth Sciences. 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 strong undergraduate backgrounds 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, 205, 302, 313, and 316 (or an equivalent) are required. Students entering this program should also have a strong mathematics background; normally, two semesters of calculus are required and a third semester is recommended.

The degree requires 24 hours of coursework 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 in hydrogeology and related areas such as environmental geochemistry, geophysics, sedimentology/stratigraphy and multiphase flow modeling. A nonthesis option is available for students who meet requirements specified in the department handbook and who are approved by department faculty; it requires 30 hours of coursework and a comprehensive examination.

All candidates must take at least six core courses from a department-approved list, including a modeling course (GEOL (EE&S) 808 is recommended), a field course (GEOL 875 is recommended) and a minimum of three other 800-level geology courses.

**INDUSTRIAL
ENGINEERING****Master of Engineering****Master of Science****Doctor of Philosophy**

Industrial engineers design, develop and improve integrated systems that include people, materials, information, equipment and energy. In addition to these issues, graduates learn to address communications throughout the organization while completing their specialized education. Focus areas for specialization are human factors, ergonomics and production and service systems. Work at the doctoral level includes independent research, dissemination of findings and preparation for research and teaching careers.

Students with baccalaureate degrees 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 competence in calculus, probability and statistics, calculus-based physics, and computing. Students admitted without this background will be required to complete successfully additional courses, some of which may not carry graduate credit.

The Master of Engineering program is an interdisciplinary program that focuses on capital projects supply chain engineering directed to working professionals. It is offered in collaboration with the Department of Management and the Department of Civil Engineering. The program is available fully in a distance learning format and courses are delivered asynchronously. Courses required in the program are IE 850, 851, 852, 853, 854, 855, 856, 857, 858, and 859, for a total of 30 hours of graduate coursework.

Master of Science students may select a thesis or nonthesis option. Students in the thesis option must complete a minimum of 30 hours of graduate coursework, including six credits of thesis research. Students in the nonthesis option must complete a minimum of 33 hours of graduate coursework.

The PhD program provides the student with a comprehensive knowledge of the field of industrial engineering and a mastery of the methods of research. A minimum of 48 hours of graduate coursework beyond a baccalaureate degree is required. Since a dissertation is mandatory for all PhD candidates, 18 hours of doctoral research are required. A qualifying examination is required, in addition to examinations required by the Graduate School. Additional information is available at www.ces.clemson.edu/ie/.

Undergraduates Involved in Graduate Programs

Undergraduate students majoring in Industrial Engineering at Clemson may take courses for graduate credit in two ways:

1. Seniors with a minimum cumulative grade-point ratio of 3.0 may apply to take graduate courses while continuing to pursue their bachelor's degrees. If successfully completed, these courses may be eligible to be counted towards a master's degree. Students selecting this option *will not* be allowed to count these courses towards the bachelor's degree. (See Graduate School form GS-6 for details.)
2. Students with a minimum cumulative grade-point ratio of 3.4 may apply to take up to 12 semester hours of courses and have them count toward *both* the bachelor's and master's degrees in Industrial Engineering. To take advantage of this opportunity, students must have a minimum cumulative grade-point ratio of 3.4, must have completed the junior year and must have been admitted to the graduate program prior to enrolling in courses. Courses eligible for this program include IE 652, 656, 660, 685, 687, 689, 691, 800, 802, 803, 804, 809, 811, 812, 813, 860, 865, 871, 880, 886, 888, and 893. The Undergraduate Curriculum Committee has preapproved these classes as acceptable technical and free electives in a student's BS program. Determination of whether the classes count towards the master's degree will be made by the student's advisory committee after he/she becomes a full-status graduate student. Students should notify the Graduate Coordinator in writing that they wish to be considered for this program. Enrollment guidelines and procedures can be found in the *Undergraduate Announcements*.

In both programs, the decision whether courses count towards the bachelor's degree is determined by the undergraduate committee and whether they count towards the master's degree is determined by the advisory committee that is formed after the student becomes a full-status graduate student.

Students should consult with their undergraduate advisor, the Graduate Coordinator and/or the Honors Coordinator before enrolling in graduate courses.

MATERIALS SCIENCE AND ENGINEERING

Master of Science

Doctor of Philosophy

Materials science and engineering is concerned with the production, properties and microstructure of the solid materials that are often the primary limitation to the advancement of modern technology. Emphasis is placed on applying the fundamental principles that govern the structure of the solid state to produce optimum mechanical, electrical, optical and other physical properties.

The curriculum provides for specialization in metallurgy, glasses and ceramics, and polymeric materials, including electronic materials, biomaterials, polymer and fiber science, textile science, polymer and textile chemistry, and fiber and composite materials.

The Materials Science and Engineering program prepares graduate students to apply science and engineering principles to solve problems related to the scientific understanding, characterization and development of new technology necessary for the processing and manufacturing of different materials and related products.

Students with a baccalaureate degree in any branch of engineering, as well as chemistry, physics and biology majors with strong mathematical backgrounds, may be admitted to the program. 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 credit hours of coursework and six credits of research. Of these 24 credit hours, a maximum of 12 credits may be taken from 600-level courses. Each master's degree student must take MS&E 826 and 827.

The Doctor of Philosophy degree provides students with a comprehensive foundation in materials science and engineering. The major field of study is generally interdisciplinary in nature, consisting of coursework in several areas of engineering and science. Comprehensive and final examinations are required. No foreign language is required, but proficiency in one is recommended.

Students should consult their advisors for course requirements. All MS and PhD students must enroll in MS&E 800 every semester.

MATHEMATICAL SCIENCES

Master of Science

Doctor of Philosophy

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 credit 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.

Together with the Department of Mathematics at Kaiserslautern University in Germany, the department offers an exchange program in mathematical sciences. In this program, one year is spent at the host university so that students can obtain two MS degrees, one from their home university and one from the host university. The degree requirements for the Clemson degree are identical to those for the nonthesis MS option. In addition, there are short-term visits in a certificate program with the Center of Industrial Mathematics at the University of Bremen in Germany.

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 credit hours of graduate coursework. Students are admitted to candidacy for the PhD degree upon successful completion of a preliminary 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 competence in advanced graduate material. The PhD program must include both a concentration area and a supporting area. Additional information is available at www.math.clemson.edu/.

Mathematical sciences courses at the 700-level are applicable to master's degree programs in the School of Education only.

MECHANICAL ENGINEERING

Master of Science

Doctor of Philosophy

Enrollment in the MS and PhD programs is open to students with degrees in physics, applied mathematics, or any branch of engineering.

Students in the MS degree program may choose the thesis or nonthesis option. Students in the thesis program must complete 30 credit hours of coursework, including six hours of thesis research and write

a thesis. Students in the nonthesis program must complete 33 credit hours of coursework and pass an exit examination. Students in the PhD program must pass a qualifying exam, complete 18 hours of dissertation research and defend a dissertation.

Programs may be selected with concentrations in mechanical and manufacturing systems design (design, dynamics, vibrations, and control, materials and manufacturing), thermal/fluid sciences (computational fluid dynamics, fluid mechanics, heat transfer, thermodynamics and energy systems), or engineering mechanics (solid mechanics, composite materials, numerical computation methods and experimental methods).

PHOTONIC SCIENCE AND TECHNOLOGY

Master of Science

Doctor of Philosophy

The Photonic Science and Technology program, jointly administered by the Center of Optical Material Science and Engineering Technologies (COMSET), the College of Engineering and Science, and the Graduate School, offers interdisciplinary graduate degrees involving science, engineering, communications, entrepreneurship, business, and leadership. The program prepares individuals with the fundamentals of the science and engineering of light and specific interactions targeted for relevance to the research areas of their home academic department(s) and collaborative co-advised graduate committees.

Students with backgrounds in any relevant science or engineering discipline who have earned an undergraduate degree from an accredited college or university may be accepted. Undergraduate prerequisite or corequisite courses may be required for applicants with undergraduate degrees in nonengineering or nonscientific disciplines.

Acceptance is determined by COMSET faculty review based on records of academic achievements, including grades from previous programs and GRE scores, and other appropriate professional accomplishments.

Each degree program is planned individually to augments the student's previous engineering and science background with adequate breadth in science or engineering and specialization in an area of photonic science or engineering. Coursework includes photonic science and technology and related engineering and sciences currently offered in the member departments and schools of COMSET.

Candidates for the MS degree are required to complete a minimum of 30 credit hours, including 12 credit hours of core courses, three credit hours of PST seminar, nine credit hours of elective courses, and an additional six credit hours of thesis research, and complete an acceptable thesis.

Candidates for the PhD degree are required to complete a minimum of 30 credit hours, including nine credit hours of core courses, three credit hours of PST seminar, nine credit hours of elective courses, and an additional 15 credit hours of dissertation research, and complete an acceptable dissertation.

PHYSICS

Master of Science

Doctor of Philosophy

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 unique intellectual opportunities. Theoretical, experimental, or computer-simulated studies of the physical universe, ranging from cosmology to quantum physics, and from atmospheric phenomena to biomolecular interactions, are available.

Normally, students are directly accepted into the PhD program. The ultimate goal is to carry out and publish independent scientific work in a chosen research field. Coursework required for the PhD includes the graduate core curriculum consisting of PHYS 811, (M E) 815, 821, 841, 951, 952 (or their equivalents at Clemson University or elsewhere as approved by the department faculty), and 12 credit hours of elective 800-900-level physics, astronomy or other graduate level courses (excluding PHYS 891/991), which must be approved by the student's advisory committee. PHYS/ASTR 875 courses may be used to satisfy this elective requirement with approval by the faculty. The purpose of these electives is to provide a well-rounded physics education and additional coursework necessary for the student's research area.

Unless they receive a deferral from the Department faculty, students must take the written PhD qualifying examination on topics from the core curriculum no later than their third semester. Students are offered two opportunities to pass the exam, which is typically offered twice annually. After passing the written PhD qualifying examination, students shall have selected a research area and faculty advisor and prepare for the oral PhD qualifying examination in which they present and defend their planned dissertation topic and research program. This oral examination must be completed within 12 months after passing the written examination. At least three weeks prior to the graduation at which the candidate expects to receive the PhD degree, a final oral examination on the dissertation must be successfully completed.

Students not passing the written PhD qualifying examination after two attempts may, with the approval of the Department faculty, complete an MS degree. Such students, and those accepted directly into the MS program, and those seeking an en-route M.S. degree usually choose to prepare a research thesis, although a nonthesis option is available. For the thesis option, 30 credit hours, including six credit hours of PHYS 891, 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.

2012-13

COLLEGE OF HEALTH, EDUCATION AND HUMAN DEVELOPMENT

The College of Health, Education and Human Development offers advanced degrees in Administration and Supervision; Counselor Education; Curriculum and Instruction; Educational Leadership; Elementary Education; Healthcare Genetics; Human Resource Development; Literacy; Middle Level Education; Nursing; Parks, Recreation and Tourism Management; Secondary Education; Special Education; and Youth Development Leadership.

The PhD degree is offered in Curriculum and Instruction; Educational Leadership; Healthcare Genetics; and Parks, Recreation and Tourism Management. The MS degree is offered in Nursing; Parks, Recreation and Tourism Management; and Youth Development Leadership. The College also offers professional degree programs leading to the Master of Arts in Teaching; Master of Education; Master of Human Resource Development; and Specialist in Education degrees. The College of Health, Education and Human Development and the College of Agriculture, Forestry and Life Sciences cooperatively offer a Master of Agricultural Education program.

The graduate programs focus on preparing students for leadership positions in educational, healthcare, governmental and business organizations. Clinical and field experiences are common in many graduate programs. Often programs join with local, state and federal agencies to provide real-world experiences and research projects for faculty and students. Some programs and courses are offered off campus and in the evening to accommodate the schedules of public schools, higher education, healthcare institutions, businesses and other organizations.

The College of Health, Education and Human Development offers graduate courses in education and nursing at various off-campus locations across the state. Off-campus course schedules for fall, spring and summer offerings for school personnel, school districts and other South Carolina agencies are published by the Office of Off-Campus, Distance and Continuing Education. In addition, courses are taught by contract with local school districts in the Clemson University service region. Courses are offered in athletic leadership and health to provide electives for students in other areas.

Programs offered in the Eugene T. Moore School of Education are accredited by the National Council for the Accreditation of Teacher Education (NCATE) and the State of South Carolina. In addition, programs training P12 personnel—teachers, counselors and administrators—are nationally recognized by specialized professional associations. Counselor education programs are accredited by the Council for Accreditation of Counseling and Related Educational Programs (CACREP).

ADMINISTRATION AND SUPERVISION

Master of Education Specialist in Education

Master of Education

The Master of Education degree in Administration and Supervision prepares individuals as elementary or secondary school administrators or supervisors. The program provides both a theoretical and field-based foundation in educational leadership with a focus on leading instructional improvement for the benefit of all P-12 students.

Admission Requirements

For admission, individuals must have a baccalaureate degree from a regionally-accredited institution and a minimum of one year of teaching experience. A complete application package should include (1) online application, (2) official transcripts from previous institutions (cumulative minimum undergraduate grade-point ratio of 2.70 on the last 60 hours), (3) two recommendations—one from immediate, prior supervisor, (4) current résumé, (5) copy of teaching and/or administration certificate and (6) GRE score report of verbal, quantitative and writing assessments. (Acceptable GRE scores are considered holistically with the student's background and potential success in graduate school.)

Applicants whose native language is not English must also submit TOEFL scores.

If requested by the program coordinator, an interview may be required prior to an admission decision.

Prospective students are encouraged to apply two months prior to the beginning of the term in which they wish to enroll.

Students who anticipate applying to a degree program may not exceed 12 credit hours without program coordinator approval and enrollment is restricted to the following courses: ED L 700, 715, 730, 735. Nondegree students should consult an advisor before enrolling in any course.

Program Requirements

This program incorporates the academic requirements for certification as a principal and supervisor in South Carolina. Thirty-six hours of graduate credit are required.

Students must complete the following core courses: ED L 710, 720, 725, 730, 745; 750 or 755; 751 or 756. In addition, five courses must be selected from ED F 778, ED L 700, 705, 715, 735, 740, 795.

Specialist in Education

The Education Specialist degree in Administration and Supervision consists of 30 credit hours and is designed to lead to certification in South Carolina as either a building level (principal) or district level (superintendent) leader. Only students who currently hold a master's degree are eligible to apply to the program.

Admission Requirements

For admission, individuals must have a master's degree from a regionally-accredited institution.

A complete application package should include (1) online application, (2) official undergraduate and graduate transcripts (cumulative minimum grade-point ratio of 3.25 on graduate work), (3) two recommendations—one from immediate prior supervisor, (4) current résumé, (5) copy of teaching and/or administration certificate and (6) GRE score report of verbal, quantitative and writing assessments. (Acceptable GRE scores are considered holistically with the student's background and potential success in graduate school.)

Applicants whose native language is not English must also submit TOEFL scores.

If requested by the program coordinator, an interview may be required prior to an admission decision.

Prospective students are encouraged to apply two months prior to the beginning of the term in which they wish to enroll.

Program Requirements

Students must complete the following core courses in sequence within three levels:

Level I—ED L 805, 820, 850

Level II—ED L 810 or 950, and 815

Level III—ED L 830, 839, 840, 851

COUNSELOR EDUCATION

Master of Education

The Master in Education in Counselor Education prepares students in one of the following specialty areas: clinical mental health counseling (CACREP-accredited), school counseling (CACREP-accredited), or student affairs. Graduate education in the Counselor Education program helps students realize their potential as practicing counselors and/or 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 the experiences provided will be rewarding and useful in today's ever-changing society.

The faculty of the Counselor Education program model the values of acceptance and human uniqueness to all students so they incorporate these values into their practice. To recruit, train and retain competent counseling and other helping practitioners, faculty members attempt to develop the following in each graduate: respect for the dignity and worth of the individual; commitment to the fulfillment of human potential; understanding of educational and counseling processes; knowledge in a particular counseling or helping field; competence in the application of professional expertise in counseling; knowledge of the role and function of professionals in related fields; commitment to inquiry; and maturity in self-development.

Clemson University recognizes laboratory settings and field-based experiences as providing the student with a realistic perspective on the field; an integrating experience for knowledge and skills acquired in the classroom; a situation that maximizes self-awareness, self-direction and self-evaluation; and 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 the focus and intensity of supervision will change as students acquire competent beginning, intermediate and advanced skills. The University and site supervisors provide each supervisee with periodic performance and evaluation feedback throughout the supervised experience. At no point is any student to engage in any field-based practicum experience without the permission of the major advisor.

Practica for the clinical and mental health and school counseling emphases require 100 hours, and internships require 600 hours of on-site counseling and/or administrative activities, a minimum of one hour of individual supervision per week, a formal log of all activities and regular meetings with the student's University and site supervisors. The Student Affairs emphasis requires one practicum of 100 hours and two internships of 150 hours each.

Each student is assigned a major advisor chosen from the Counselor Education faculty. Students are required to meet with their advisor at least once a semester to ensure appropriate course sequencing.

Students in the clinical mental health counseling and school counseling programs should plan to take the written final examination during their final semester in the program, with approval from their advisor.

Admission Requirements

Applicants must have an undergraduate grade-point ratio of 3.0 on a 4.0 scale (last 60 hours of undergraduate coursework). A complete application package should include online application, GRE scores, personal statement, two letters of recommendation and approval of the Counselor Education faculty. Applications admission to the Clinical Mental Health Counseling Emphasis Area are due by February 1 for summer and fall admission; and by October 1 for spring admission. Applications for the School Counseling Emphasis Area are due February 1 for summer and fall admission. School Counseling does not admit students for spring. Applications for admission to the Student Affairs Emphasis Area are due by February 1 for summer and fall admission; and by October 1 for spring admission. Spring admission for Student Affairs is for part-time enrollment only.

The Clinical Mental Health Counseling Emphasis also requires a minimum of 12 credit hours of psychology and/or sociology, graduate or undergraduate. This coursework must be completed prior to enrollment in the program or by the end of the first year the student is enrolled in the program.

Additional information is available at www.grad.clemson.edu/hehd/departments/education.

Testing Requirements

Students in all Counselor Education programs take written final examinations, which are graded on a pass/fail basis. Passing this examination is required for the degree. With the advisor's permission, students are eligible to take the final examination. At least two committee members must pass the student. If a student does not pass the written final examination, the major advisor may recommend a second written or oral examination. This recommendation may be during the same semester or in the following one. If the student fails the written examination twice, he/she will be removed from the program.

Clinical Mental Health Counseling Emphasis

Students with an emphasis in Clinical Mental Health Counseling will demonstrate an ability to work effectively 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 communicate effectively with diverse cultural groups; a knowledge about counseling across the lifespan; 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. Additional information is available at www.grad.clemson.edu/programs/counseloreducation.

The Clinical Mental Health Counseling Emphasis requires 60 credit hours arranged as follows:

Area of Specialization—45 credit hours: ED C 805, 810, 811, 812, 813, 814, 815, 816, 818, 821, 822, 823, ED F 701, 778, and three elective hours as approved by advisor.

Field Experiences—15 credit hours of ED C 836, 846. Students must complete 21 credit hours before participating in internship.

School Counseling Emphasis

Students with an emphasis in School Counseling will demonstrate an ability to work effectively with students, teachers, administrators and other members of the community, as well as a high level of expertise in counseling appraisal, theory, skills and intervention techniques.

Qualification for state and national certification as school counselors includes an 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; and ability to perform in a consultative capacity both within and outside of the school environment. Additional information is available at www.grad.clemson.edu/programs/counseloreducation/school-counseling.php.

The School Counseling Emphasis requires 60 credit hours, arranged as follows:

School Counseling Core—24 credits: ED C 810, 811, 812, 813, 814, 815, ED F 701, ED L 839

Area of Specialization—21 credits: ED C 801, 807, 818, 851, ED SP 853; and six elective hours selected from a department-approved list.

Field Experiences—15 credits: ED C 830, 841

Testing Requirements

In addition to successful completion of the written final examination, students must pass the PRAXIS II Subject Assessment test in School Guidance and Counseling. The score must be reported to Clemson and must be recorded in the student's file before certification verification will be sent to any State Department of Education.

Student Affairs Emphasis

Students with an emphasis in Student Affairs will demonstrate the ability to work effectively with faculty, students, administrators and other members of the academic community; preparation for employment in higher education settings in a variety of roles; the 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; the ability to communicate effectively 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. Additional information is available at www.grad.clemson.edu/programs/counseloreducation/student_affairs.php.

The Student Affairs Emphasis requires 48 credit hours arranged as follows:

Core Courses—18 credit hours: ED C 810, 811, 812, 814, 815, and three elective hours

Field Experiences—nine credit hours: ED C 834, 844

Specialization Courses—21 credit hours: ED C 803, 804, 806, 809, 819 ED L 765, 855

Testing Requirements

In addition to successful completion of the final examination, students also complete an electronic portfolio as part of the program requirements.

CURRICULUM AND INSTRUCTION

Doctor of Philosophy

The Doctor of Philosophy degree in Curriculum and Instruction is a research degree that prepares students to become scholars who can discover, integrate and apply knowledge, as well as communicate and disseminate it. The intent of the program is to prepare students to make significant original contributions to knowledge in specialized fields. 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 coursework 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 coursework, internships, the comprehensive exam, the dissertation proposal and oral defense of the dissertation as directed by the student's advisory committee. Students must maintain a *B* average in all graduate work. The degree usually requires a minimum of 65 credit hours beyond the master's degree, selected from the areas prescribed by the requirements of the PhD in Curriculum and Instruction. Listed below are the guidelines or normal expectations for a student receiving the PhD 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.

Specialty areas require 6–18 credits in courses outside the School of Education. This approved coursework is intended to provide a concentration within the specialty area and/or exposure to disciplines outside the School of Education.

Admission Requirements

A complete application package should include proof of a master's degree, official undergraduate and graduate transcripts, GRE scores, a résumé showing relevant professional experiences and a personal statement of professional history, goals and aspirations. Candidates passing initial committee review are invited for an interview. Students whose native language is not English must take the Test of English as a Foreign Language (TOEFL). The deadlines for admission consideration are October 15 and March 15.

Core Requirement 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.

Course Requirements

The Curriculum and Instruction Program requirements are as follows:

Doctoral Seminar—Two credit hours.

Core—21 credit hours of core coursework represented by the following areas: Curriculum, Instruction and Assessment. Students successfully complete at least four courses representative of both quantitative and qualitative research methods and procedures.

Area of Specialization—24 credit hours of specific courses and minimum requirements determined by the student's doctoral committee that must include:
 1. Courses and/or equivalent experiences to demonstrate competency in teaching and research practice (for example, ED 894 and 980).
 2. 18 hours of specialized focus.

Dissertation—18 hours of ED (ED F, ED SP) 991

Elementary Education Emphasis

Students with an emphasis in Elementary Education will demonstrate (1) in depth knowledge 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, in particular, design, implementation and evaluation of curriculum; effective instructional methods; and current issues and trends affecting teaching and/or learning; and (2) competence in research and evaluation. Students will be expected to apply their research skills to problems and topics related to elementary school curriculum, instruction, and ancillary programs.

The Elementary Education Emphasis Area requires ED (ED F, ED SP) 980, ED EL 937, 938, plus 21 additional credit hours approved by the doctoral committee. A three-hour internship is required.

Reading Education Emphasis

Students with an emphasis in Reading will demonstrate (1) in depth knowledge in the field of reading with an understanding of the learning and instructional needs of all students, in particular design, implementation and evaluation of curriculum; effective instructional methods; and current issues and trends affecting teaching and/or learning; and (2) competence in basic and applied research and evaluation. Students will be expected to apply their research skills in the field of reading.

The Reading Education Emphasis Area requires PSYCH 833, EDLT 939, 944, plus 12 additional credit hours selected from EDLT 884, 885, 886, 887, 937, 938, 940, 941, 942, 943, 945. A six-hour internship is also required.

Secondary Education Emphasis

The PhD program in Curriculum and Instruction with an emphasis in English Language, Mathematics, Natural Sciences, or Social Studies has five possible professional market niches. The student's program for each niche will contain appropriate study in both that subject area and that 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 federal government agency; (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 an emphasis in English Education will demonstrate a research knowledge base that includes the areas of teaching composition, literary response, language development, developments in English language, and multimedia applications for the English classroom.

Mathematics Education Goals—Students completing an emphasis in Mathematics Education will develop a knowledge base in current mathematics education issues, research, and classroom applications and be able to select and pursue appropriate research topics in mathematics education.

Science Education Goals—Students completing an emphasis in Science Education will demonstrate an understanding of how science process and content is most effectively learned, the components of state-of-the art curriculum models, and the utilization of the most effective research methodologies designed to expand the theory base.

Social Studies Education Goals—Students completing an emphasis in Science Education will demonstrate an understanding of how science process and content is most effectively learned, the components of state-of-the art curriculum models, and the utilization of the most effective research methodologies designed to expand the theory base.

The Secondary Education Emphasis requires 30 credit hours arranged as follows:

Concentration—18 credit hours of advanced coursework in a discipline or related areas

Internship—three to six credit hours

Advanced studies in the teaching of English, mathematics, science, or social studies—three hours from the appropriate area: EDSEC 841, 842, 843, or 844

Current Literature in Education—three hours from the appropriate area: EDSEC 846, 847, 848, or 849

Special Education Emphasis

Students with an emphasis in Special Education will demonstrate: (1) In depth knowledge of disability and at-risk characteristics integrated with an understanding of how these characteristics relate to the learning and instructional needs of individuals in the (a) delivery of effective curricular and instructional, functional interventions, (b) philosophical and social contexts of special and general education, and (c) legal and organizational context of special and general education; and (2) competence in basic and applied research and evaluation, emphasizing special methodological concerns and evaluation of services with individuals with disabilities and at-risk characteristics.

The Special Education Emphasis requires ED (ED F, ED SP) 980, ED SP 853, 930, 934, 935, and 12 credit hours of elective coursework that may include ED 901, 938, ED SP 936, 937.

EDUCATIONAL LEADERSHIP

Doctor of Philosophy

The PhD program in Educational Leadership provides students with a strong background in five domains: leadership, research, policy, ethics and diversity. As the highest academic degree granted by Clemson University, the PhD prepares students to become scholars who can discover, integrate and apply knowledge as leaders in schools and post-secondary and community educational institutions and agencies. This is accomplished through close association with and apprenticeship to faculty members experienced in research, teaching and administration.

Admission Requirements

Complete application package should include competitive GRE scores, official bachelor's and master's degree transcripts, three letters of recommendation, current curriculum vita, and a cover letter. The cover letter must be two or three pages and should discuss (1) the candidate's reasons for pursuing the PhD degree in Educational Leadership, particularly as relate to career and professional goals (elementary and secondary education or higher education); (2) one or more issues on which the candidate might like to do research; and (3) distinguishing characteristics that demonstrate the candidate's potential for success in the program. This letter will be evaluated as a writing sample.

Program Requirements

A student admitted to the Educational Leadership program must begin coursework within one year from the semester of acceptance or reapply for admission. Two concentrations—P12 and Higher Education—are offered for candidates pursuing the PhD in Educational Leadership. All candidates must take a minimum of 58 credit hours of graduate-level courses beyond the master's degree and complete an 18-hour dissertation project. The program core consists of a minimum of nine credits completed within the first two years of enrollment culminating in the Preliminary Exam. Upon successful completion of Preliminary Exam, students consult with their doctoral advisory committees establishing their program of studies, including courses in concentration, research, internships and cognates. Internships are supervised by a practicing educational leader and by a faculty member. The internship experience is designed to acquaint the student with the practical applications of education theory in a planned, extensive and closely monitored opportunity for the student to work in a setting that reflects the student's long-range goals and the requirements for rigorous applied research. Cognates are courses from academic fields supporting the student's research agenda. Upon completion of program of studies coursework, students qualify as doctoral candidates by successfully completing a comprehensive exam. The culminating requirement for the program is successful completion of the dissertation as guided by the major advisor and the doctoral advising committee.

Course Requirements

Preliminary Core Courses—The following credits are required before taking the preliminary exam: ED L 900, 905, 910, plus a research course.

Concentration—A minimum of 18 credit hours, selected with the advice of the doctoral advisory committee, is required.

Research—Students must complete a qualitative research course (e.g., ED F 879), an intermediate and advanced research course (e.g., ED F 878, EX ST 801), and a series of directed research core courses (ED L 988, 989, and 990).

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

Dissertation—A minimum of 18 credit hours (ED L 991) is required for the dissertation.

Internship—All students are required to complete six hours of field research internship credit (ED L 985 and 986).

HUMAN RESOURCE DEVELOPMENT

Master of Human Resource Development

The human resource field is a specialized blend of education, systems design, consulting, psychology, management and sociology. The Master of Human Resource Development (MHRD) degree prepares professionals to work as trainers/instructional designers, human performance improvement (HPI) specialists and consultants within business, industry, non-profit and government organizations.

HRD/HPI professionals commonly provide diagnostic and intervention strategies related to the areas of technical and interpersonal skills, management, human and organizational performance and motivation. The MHRD program involves and enhances human performance in the workplace. The program is designed for professionals with three or more years of experience and is delivered in an interactive online format. The curriculum consists of 12 courses delivered over a two-year period in a cohort setting. Graduates of the program are capable of utilizing contemporary instructional and human performance technologies and methodologies. Program participants gain valuable skills and knowledge that accelerate their careers.

Admission Requirements

Applicants to the MHRD program follow general admission procedures as prescribed by the Graduate School. Note: The deadline to apply to the MHRD program is July 1. Every required item in support of the application must be on file by that date. The complete application package should include the following: baccalaureate degree with a preferred minimum grade-point ratio of 3.0, transcript, résumé, letter describing professional goals, two letters of reference and GRE scores. Applicants must possess three years of relevant full-time work experience and complete the on-line Keirsey™ Temperament Sorter®-II and Campbell™ Interest and Skill Survey®. These assessments are available at www.keirseycampbell.com/. (Click on Purchase Here. Use the promotion code CLEMSON23 to have scores for both assessments sent to the MHRD admissions committee. A nominal fee is charged for these assessments.)

Program Requirements

All courses are delivered through distance education technologies. Students need access to e-mail and the Internet and the ability to read a CD-ROM or DVD. Students also need current versions of operating systems, word processing, spreadsheet and presentation software. Since the required courses involve sending and receiving large files of information, students will need a computer equipped with a Web cam, microphone and DSL or high-speed internet connection.

The MHRD program consists of 36 credit hours of coursework arranged as follows:

First Year

Fall Semester

3 - H R D 820 Human Performance Improvement	
3 - H R D 830 Concepts of Human Resource Dev.	6

Spring Semester

3 - H R D (CTE) 847 Instructional Syst. Design	
3 - H R D 880 Research Concepts and Skills	6

Summer

3 - H R D (CTE) 870 Consulting for Education and Industry	
3 - H R D 890 Instrumentation for Human Performance Improvement	6

Second Year

Fall Semester

3 - H R D (CTE) 845 Needs Assessment for Education and Industry	
3 - H R D (CTE) 860 Instructional Materials Development	6

Spring Semester

3 - H R D 849 Evaluation of Training and Development/HRD Programs	
3 - H R D 897 Appl. Research and Development	6

Summer

3 - H R D 825 Organizational Performance Improvement	
3 - H R D 882 Knowledge Management for Improved Performance	6

36 Total Semester Hours

Students must satisfy requirements for the Graduate School, complete the approved program of study for the degree, maintain a *B* average in all graduate coursework and pass a comprehensive exam.

ATHLETIC LEADERSHIP CONCENTRATION

First Year

Fall Semester

3 - H R D 820 Human Performance Improvement	
3 - H R D 830 Concepts of Human Resource Dev.	
6	

Spring Semester

3 - H R D (CTE) 847 Instructional Syst. Design	
3 - H R D 880 Research Concepts and Skills	
6	

Summer

3 - A L 862 Psychological Issues and Collegiate Athletics	
3 - H R D 890 Instrumentation for Human Performance Improvement	
6	

Second Year

Fall Semester

3 - A L 849 Athletic Leadership Development	
3 - H R D (CTE) 860 Instructional Materials Development	
6	

Spring Semester

3 - A L 864 Ethical Issues in Collegiate Athletic Administration	
3 - H R D 897 Appl. Research and Development	
6	

Summer

3 - A L 861 Athletic Leadership for Intercollegiate Administration	
3 - H R D 882 Knowledge Management for Improved Performance	
6	

36 Total Semester Hours

Students must satisfy requirements for the Graduate School, complete the approved program of study for the degree, maintain a *B* average in all graduate coursework and pass a comprehensive exam.

LITERACY

Master of Education

The purpose of the MEd degree in Literacy is to educate reading professionals who have an in-depth knowledge of reading theories, processes, strategies, curriculum and research, and who can use that knowledge to plan appropriate reading programs and curricula for a variety of contexts and communicate information to a wide variety of audiences.

Objectives

Graduates with the MEd in Literacy will demonstrate (1) an understanding of reading as the process of constructing meaning through the interaction of the reader's existing knowledge, the information suggested by the written language and the context of the reading situation; (2) knowledge of the influence of cultural, ethnic and linguistic backgrounds on the reading process and how to use what the reader brings

to the reading experience; (3) an understanding of relationships among the language processes of reading, writing, listening and speaking; (4) support for students in acquiring the ability to monitor comprehension and reading processes and apply appropriate strategies for a variety of purposes; knowledge of assessments that involve multiple indicators of learner progress; (5) development of an environment that motivates students to pursue and respond to reading and writing for personal growth and development; (6) understanding of English language learners' literacy and language development and expertise in supporting their literacy learning through strategic teaching; (7) classroom-based research in reading; and (8) expertise in sharing knowledge of reading research and instructional practices with peers.

Admission Requirements

Complete application package should include a completed application, statement of purpose (professional goals and philosophy of teaching), a valid teaching certificate, two letters of recommendation, an undergraduate transcript with a grade-point ratio of 3.0 on a 4.0 scale (last 60 hours), and competitive GRE scores.

Program Requirements

The program requires 36 credit hours of coursework and a satisfactory score on the final exam. The following courses are required of all students: ED F 702, 808, EDLT 860 (prerequisite for ESOL Emphasis), 861, 862, 863, 864, 865, 866.

The MEd in Literacy offers five plans for completion of course requirements:

Reading Teacher and Reading Consultant Certifications—In addition to the required core courses above, students must take nine additional credit hours of reading/language arts courses selected from ED F 880, ED SP 820, ENGL 700, EDLT 867, 868, 869, 870, 871, 872, 873, 882, 883.

Reading Teacher and Reading Consultant Certifications Plus Reading Recovery Training—(Three years teaching experience are recommended as training prerequisite.) In addition to the required courses above, students are required to take EDLT 880, 881, and three additional credit hours selected from ED F 880, ED SP 820, ENGL 700, EDLT 867, 868, 869, 870, 871, 872, 873, 882, 883.

Reading Teacher, Reading Consultant and Reading Coordinator/Director Certifications—In addition to the required courses above, students are required to take nine credit hours arranged as follows: three hours selected from ED C 801, 811, 812; three hours selected from ED EL 760, EDSEC 765; three hours selected from ED L 705, 720, 730, 735.

Early Literacy Emphasis with Reading Teacher and Reading Consultant Certifications—In addition to the required courses above, students are required to take nine additional credit hours selected from EDLT 870, 871, 872, 873.

English Speakers of Other Languages with Reading Teacher and Reading Consultant Certifications and ESOL Certification Support—In addition to the required courses above, students are required to take ED 839, ED SP 823, EDLT 870, 874.

MIDDLE LEVEL EDUCATION

Master of Arts in Teaching

The Master of Arts in Teaching degree is designed for mid-career professionals who are seeking to change fields and for students with backgrounds in content areas who are not currently certified to teach. The program in Middle Level Education possesses several intrinsic advantages over other initial certification programs. Most importantly, it places well-prepared candidates in the classroom in a timely manner. An individual possessing a bachelor's degree in a content or closely related field is given an intensive one-year, field-based experience. He/she can then expect to start in the classroom as a first year teacher after a full academic year (including summer sessions).

The objectives of the Master of Arts in Teaching in Middle Level Education are to promote the entrance of content-ready individuals into the South Carolina classroom in a timely manner and to provide a rigorous yet plausible route for individuals seeking to change careers and enter teaching.

Admission Requirements

Acceptance is based on a combination of test scores, interviews and academic record. Applicants are expected to take the Praxis II exams in the two content areas in which they plan to receive certification. They are required to have passed one of these Praxis II exams to be admitted to the program.

Program Requirements

The MAT program, offered at the University Center of Greenville, is composed of three elements: core pedagogical coursework, content coursework and an intensive field-based component. Core courses are taken by cohort students in a block—two during first summer session, three in the fall and three in the spring. This includes six hours of Methods Practicum, three in each area of content certification. These six credit hours meet the State's requirements for student teaching. The remaining 12 credit hours are taken individually in the content areas.

Students in the MAT block begin during the fall semester when public schools begin. They spend the full day in the schools.

In the spring, students begin the semester with two weeks of intensive classroom work in the three remaining core courses. These courses are considered "bookend" classes that bracket the student teaching experience. The methods practicum/student teaching includes a portfolio assignment.

The MAT in Middle Level Education program requires 36 credit hours, arranged as follows:

Summer Session I Block Courses—ED F 702, 703

Summer Session II Block Courses—content courses at the master's level approved by advisor

Fall Semester Block Courses—ED 641, ED F 808, and one three-hour methods course

Spring Semester Block Courses—ED SP 823, EDLT 867, and one three-hour methods course

Content Area Courses—12 credit hours scheduled by the student and advisor

SECONDARY EDUCATION

Master of Arts in Teaching

The Master of Arts in Teaching in Secondary Science or Secondary Mathematics is a 39 semester hour program that can be completed in 13 months and is offered in the Greenville area. It consists of on-line and face-to-face instruction, and more than 100 hours of field experience prior to student teaching.

The MAT program is a technologically rich program in which students master the fundamentals of teaching and become skilled at motivating and helping students learn either science or mathematics at deep levels. The program addresses content directly related to the secondary classroom, educational foundations, and specific teaching methods that reflect current research in the field.

The program also provides the courses required for initial certification for grades nine through twelve in South Carolina. The program is geared primarily towards adults with a background in science, mathematics, or a related discipline who wish to change careers and enter the teaching field.

Admission Requirements

The optimal entry point into the MAT Program is during the Summer I term with a projected graduation the following summer. The program application deadline is April 1.

To be considered for admission, individuals must:

- Complete the online application to the Clemson University Graduate School. To ensure full consideration, applications must be received by the April 1 deadline. On the application, select Program Code 385 (Secondary Education) and indicate either science or mathematics within the application.
- Submit official transcripts from all prior institutions from which a degree was awarded or from which transfer credit is desired. A Bachelor's degree or higher is required from an accredited institution. Prior coursework should show completion of at least 30 semester credits with a C or better in the certification area or closely related discipline. Note: Additional coursework may be required to address deficiencies.
- Provide evidence of content mastery in desired field. Students are strongly encouraged to submit a passing score on the 0030 or 0070 Praxis II exam for science or the 0061 Praxis II exam for mathematics as evidence with their application. A passing score must be on file at Clemson prior to student teaching.
- Complete a departmental interview (can be scheduled before or after all application materials have been submitted).
- Include two recommendations. (Note: Recommendation forms may be sent to recommenders electronically from the online application, or PDF recommendation forms can be sent for recommenders to complete and return to the Graduate School.)
- Submit TOEFL scores, if English is not the student's first language.
- Submit a resume and indicate relevant professional work experience. Three or more years of professional experience beyond the Bachelor's degree is recommended.

Curriculum

The MAT program is composed of three elements:

1. Core pedagogical coursework (15 hours),
2. Content coursework (9 hours), and
3. Practicum and internship components (15 hours)

The discipline-specific methods courses, practicum and content literacy courses, taken in the fall semester, require students to complete a field experience in a local public high school, during which they spend two days per week in the assigned placement. During the spring semester, students complete a 15-week directed internship (student teaching) and a Capstone Seminar.

Course of Study

Summer Session I (6 credits)

Summer Session II (6 credits)

- Content Course¹
 - Teaching Students with Individual Differences and Exceptionalities
- Fall Semester (12 credits)
- Classroom Assessment Methods
 - Content Area Literacy
 - Tests and Measures
 - Classroom Management

MAT Spring Semester Session I (12 credits)

- Directed Internship (student teaching)
- Internship and Research Seminar

Summer Session I (3 credits)

- Content Course¹

Note 1: Content area courses must be approved by the program advisor.

Total Hours: 39

Program Requirements

Completion of the MAT for Secondary Science or Mathematics degree program is dependent upon:

- Completion of all required prerequisites
- A record of all state-required Praxis II exams on file at Clemson University, prior to student teaching. This includes a passing score on the 0030 or 0070 for science students or the 0061 for math students. Note: Passing scores on the following tests are required for certification.
- Science: 0030 or 0070: 0624
- Math: 0061, 0063, and 0624
- Additional information can be found at <http://www.ets.org/praxis/sc/requirements>
- Completion of all coursework with a grade of C or better
- Successful completion of student teaching experience

SPECIAL EDUCATION

Master of Education

The Master of Education degree in Special Education ensures that students are knowledgeable in the field of special education. The program in Special Education prepares students in one of the following areas: 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. The prescribed program of study enables students to identify important legal and policy issues in special education, demonstrate knowledge of the research processes within the field of special education, demonstrate knowledge of specific characteristics of individuals with mild disabilities and implement

research-validated interventions for students with disabilities in a variety of settings. Successful graduates will evaluate critically the literature in the field, recognize and evaluate current issues and problems in special education and identify potential solutions for these problems.

Graduate students must satisfy requirements of the Graduate School, complete the approved program of study for the degree, maintain a B average in all graduate work and pass a final exam. The degree requires 36 credit hours. In addition to successfully completing all required coursework and comprehensive exams, candidates must have on record scores for all PRAXIS II exams required by South Carolina for certification in their area of specialization (Learning Disabilities, Intellectual and Developmental Disabilities, or Emotional/Behavioral Disorders) prior to graduation.

Admission Requirements

A complete application package should include a bachelor's degree, a valid teaching certificate, two letters of recommendation, an undergraduate transcript with a grade-point ratio of 3.0 on a 4.0 scale (last 60 hours), and competitive GRE scores.

Program Requirements

Required Courses—ED F 778, ED SP 820, 821, 822, 823, 841, 853, 854

Area of Emphasis—9-12 credit hours

Students choose from one of the emphasis areas below. Courses in each area partially fulfill requirements for South Carolina certification in that area.

Emotional/Behavioral Disabilities Disorders—ED SP 669, 674, 675, 678*

Learning Disabilities—ED SP 670, 675, 676*

Mental Retardation—ED SP 672, 673, 679

Electives—Three credit hours are required. EDLT 865 is recommended for those intending to work in elementary settings. ED SP 840 is recommended for those intending to work in secondary settings.

**ED SP 675 is required for South Carolina certification in Emotional/Behavioral Disabilities and should be included in the program of study in lieu of elective hours unless it has been taken previously.*

TEACHING AND LEARNING

Master of Education

The Master of Education in Teaching and Learning includes coursework in research methods and action research, educational tests and measurement, curriculum theory and development, educational psychology, and schooling context. Students may elect to specialize in one of the following emphasis areas: Early Childhood Education, Elementary Education, Secondary English Education, Secondary Mathematics Education, Secondary Science Education, or Secondary Social Studies Education. The program is intended to strengthen and enhance teaching skills, promote research and reflection on innovative teaching strategies, and expand content knowledge.

Admission Requirements

A complete application package should include a bachelor's degree, a valid teaching certificate, two letters of recommendation, an undergraduate transcript with a grade-point ratio of 3.0 on a 4.0 scale (last 60 hours), and competitive GRE scores. Before enrolling in any graduate course, the student should arrange a conference with the major advisor. Courses taken prior to this conference may not be acceptable for the degree. Professional development courses will not count toward the degree. Exceptions to the program of study must be approved by the student's advisory committee, which consists of the major advisor and two faculty members from the department in which the student has taken coursework.

Degree Requirements

Graduate students must satisfy requirements for the Graduate School, complete the approved program of study for the degree, maintain a *B* average in all graduate work and pass a comprehensive exam. The degree maintains 30 credit hours (33 for those who have not successfully completed an undergraduate content reading course).

When the student has successfully completed 24 hours toward the degree, he/she may take the final written examination. The examination is arranged at a specified time each semester.

Core Courses—18 credit hours

ED F 778, ED EL 760, ED F 702, 770, ED 860, 808

Specialty Courses—12 credit hours

Specialty courses must be chosen in conjunction with the major advisor. Specialty coursework should be related to one of the following emphasis areas: Early Childhood Education, Elementary Education, Secondary English Education, Secondary Mathematics Education, Secondary Science Education, or Secondary Social Studies Education.

YOUTH DEVELOPMENT LEADERSHIP

Master of Science

The Master of Science degree program in Youth Development Leadership equips students with the competencies, knowledge and skills to help young people develop into healthy, competent, coping and contributing citizens. This program prepares students to address issues facing youth in the context of family and community with an emphasis on positive outcomes through a dynamic learning environment.

The MS in Youth Development Leadership program is an interdisciplinary degree primarily involving departments and units in the College of Health, Education and Human Development but also including academic areas from other colleges and units at the University. This program is designed to meet the needs of students who are also working professionals. All courses are offered in an accelerated format and are delivered through a variety of asynchronous and synchronous distance education technologies. Minimum technology requirements for this program include access to e-mail and the Internet with the ability to read CD-ROMs and DVDs.

This program has a strong relationship with youth-related agencies/organizations and engages them in learning and experiential opportunities for students. The Youth Development Leadership program is designed to empower students to focus on strengths and assets within the context of family and community that will promote positive youth development; identify and examine physical, emotional, environmental and social issues related to being a young person in today's society; prepare professional educators and leaders at all program and management levels for careers in schools, agencies, institutions and community groups that serve youth; train new and current professionals to be well prepared with increased knowledge and enhanced skills in the youth development area; prepare leaders who will have an immediate impact on youth development in South Carolina and around the nation; link formal and non-formal prevention and intervention youth programs to enhance the learning experience for students; and enhance youth serving agencies and organizations by supplying professionals who are competent in child and adolescent growth and development.

The Master of Science in Youth Development Leadership requires 36 semester hours of coursework as follows: EX ST 801, HEHD 800, 801, 802, 803, 804, 805, 806, 807, 808, 891, 892.

Admission Requirements

A complete application package should include proof of a baccalaureate degree with a minimum grade-point ratio of 3.0 on a 4.0 scale, an acceptable score on the Graduate Record Examination (GRE), a letter of intent and two letters of reference. Experience in the field of youth development is preferred.

HEALTHCARE GENETICS

Doctor of Philosophy

The interdisciplinary Doctor of Philosophy degree program in Healthcare Genetics, provided through the School of Nursing, offers individuals from multiple health-related disciplines the opportunity to achieve a terminal degree in Healthcare Genetics. The curriculum builds partnerships with more than six disciplines focusing on genetics, health policy and ethics, theory development and quantitative and qualitative research methods. Three specialty research tracks promote advanced study in Translational Genetics [Bench Research], Applied Population Genetics as an Interventionist, or Genetics in Ethics/Health Policy. Seminars and electives bring the cognate hours to 18. With 18 hours of dissertation (requirements met as manuscripts submitted for preparation), the total credit hours required is 70. This can be accomplished full-time over a four-year period, including two summers of study.

The PhD program in Healthcare Genetics prepares interdisciplinary scientists to extend the knowledge base relevant to healthcare genomics, translate research to advance the application of genomics in healthcare and collaborate in interdisciplinary research and practice.

Objectives of the program are as follows:

1. Collaborate with other disciplines to generate knowledge and develop theories that focus on the genetic aspects of actual and potential health problems of diverse individuals, families, groups and communities while addressing health disparities.
 2. Formulate health promotion, disease prevention, and treatment strategies that translate and integrate genomic knowledge from a variety of disciplines.
 3. Demonstrate leadership that facilitates interdisciplinary development and application of ethical guidelines and health policy in genetics.
 4. Disseminate research findings to develop healthcare models that incorporate the expanding knowledge of genetics.
- Coursework includes a variety of on-line, Web-enhanced and traditional classroom settings. Core courses are available on the Clemson University campus, as well as a variety of other institutions.
- ### Admission Requirements
- Students applying for the Healthcare Genetics program will have at least a bachelor's degree in a related health science discipline from an accredited institution. Other requirements include the following:
1. GRE scores equivalent to the current scores of 500 for verbal and quantitative sections and 4.0 for the analytical writing section
 2. Master's (MS/MA) thesis or publications. (BS applicants entering without a data-based research experience will be required to complete satisfactorily a research project utilizing the six hours of cognate electives prior to beginning the core courses in the doctoral program.)
 3. Submission of a curriculum vita
 4. Written statement of career goals
 5. Graduate School application with three letters of recommendation from professionals that address research and scholarly potential
 6. Interviews with two faculty members (may be conducted in person, Polycom, or telephone depending on individual circumstances)
 7. Cumulative grade-point ratio of 3.4 or higher in the undergraduate (and/or graduate programs if applicable)
- The curriculum is composed of 12 core courses and three cognate specialties/tracks. The core curriculum provides 34 hours of coursework in the areas of genetics, health policy and ethics, theory development and quantitative and qualitative research methods. In the specialty cognates, students pursue advanced study in Basic Genetics [Bench Research], Applied Population Genetics as an Interventionist, or Genetics in Ethics/Health Policy. Seminars and electives bring the cognate hours to 18. With 18 hours of dissertation (requirements met as manuscripts submitted for preparation), the total credit hours required is 70. This can be accomplished full-time over a four-year period, including two summers of study.
- The coordinator of the PhD program in Healthcare Genetics, in concert with individual faculty advisors, will work with each student to determine the requirements for their program of study. The plan of study for a student entering with a bachelor's degree will be developed that reflects prior coursework, required prerequisites and data-based research experiences. Students without previous biochemistry courses will be required to take BIOCH 632 or its equivalent.
- Comprehensive exams and 18 hours of dissertation research are required (to be developed as a manuscript for publication).

INTERNATIONAL FAMILY AND COMMUNITY STUDIES

Doctor of Philosophy

Certificate

The doctoral program in International Family and Community Studies educates professionals to generate, diffuse, and apply knowledge needed to strengthen communities' capacity for family support, meaningful participation, and strong relationships, including mutual assistance. The program prepares graduates as (1) scholars in interdisciplinary institutes or academic departments on child and family studies, social policy studies, international studies, or community development; or (2) researchers, planners, or administrators in domestic or international governmental or nongovernmental agencies concerned with children, families, and/or communities.

The program is based in the Institute on Family and Neighborhood Life and relies on the Institute's ties with related university programs in Africa, Asia, Europe, and Latin America. Students also have the opportunity to participate in the Institute's community development, policy consultation, and empirical research projects in South Carolina and other states and nations.

With its focus on family and community life, the program touches on the most fundamental aspects of people's everyday lives. Blending the humanities, the social sciences, and various professional disciplines, the program may be unique in its integration of normative analysis (i.e., philosophical, legal, and religious studies), empirical research, and community development. With a foundation in the study of human rights as applied to children and families around the world, the program builds a comparative understanding of U.S., foreign, and international law and policy on child and family issues and of the significance of democracy for the well-being of individuals, families, and communities. Students acquire an appreciation of the role of civil society (e.g., voluntary associations and nonprofit organizations) and primary community institutions (e.g., schools) in promoting and maintaining democracy. Such studies provide the foundations for an understanding of the principles and practices of community development and transformation, humanitarian assistance, and responsive human services. The important role and features of effective informal mutual assistance mechanisms in community life and their meaning for children and families are also explored.

To provide a richer understanding of human development and family life and to build skills for work in diverse cultures, international study is emphasized. Students are encouraged to become proficient in studies of world regions and in communication in a language other than their own. Building on the Institute's relationships with universities in developing and transitional countries, students often spend time at an affiliated center outside North America, where they engage in supervised research and/or public service.

Admission Requirements

Applicants must hold a bachelor's or a master's degree from an accredited degree program. In addition to strong academic performance, experience

in volunteer and/or professional public service is desirable. Students must submit GRE and/or Miller's Analogy Test scores, three letters of recommendation from professionals familiar with the applicant's academic work and/or community service, and a 500-word essay on the applicant's career aspirations and goals and their relation to this graduate program. Students for whom English is not the first language are also required to submit TOEFL scores. Both U.S. and international students are welcome, as are both new graduates and experienced professionals.

Program Requirements

The degree requires 66 credit hours of postbaccalaureate work. A minimum of 30 hours is required of postmaster's degree students. The normal course of study requires four years for postbaccalaureate students.

The program requires FCS 810, 811, 820, 821, 822, 830, 831, 832, 833, 836; plus twelve credits selected from ANTH 603, FCS 840, 892, PSYCH 810, 811, or SOC 805.

In addition, six credits of language studies are required. (These credits may be at the undergraduate level.) Eighteen credits of dissertation research (FCS 991) are required. Students entering postbaccalaureate must also complete six hours of FGS 890.

Certificate

With the approval of the Institute Director or Associate Director, domestic or international students with a bachelor's degree are admitted to the certificate program.

With advice from an Institute faculty member, students select one of four tracks and develop a plan of study based on courses selected from the following: FCS 810, 811, 812, 820, 821, 822, 830, 831, 832, 833, 835, 840, 890, 892, 893.

NURSING

Master of Science

The Master of Science degree program with a major in Nursing builds upon the first professional degree. The student acquires knowledge and skills in advanced nursing: clinical nurse specialist (CNS), nurse practitioner (NP), nurse administration, or nursing education. The student may select one of the following study options: child/adolescent nursing (CNS), adult/gerontological nursing (CNS), adult/gerontological nurse practitioner (ANP), family nurse practitioner (FNP), nurse administration, or nursing education. All graduate options articulate with the baccalaureate program in the continued acquisition of advanced nursing knowledge and skills. This specialization builds toward advanced nursing knowledge in selected practice and role areas. Theory, research and role development are emphasized to enable graduates to participate in the development of nursing knowledge and contribute to the advancement of the nursing profession.

The objectives of the Master of Science degree program in Nursing are to provide graduates with the ability to integrate advanced knowledge from nursing and related disciplines into a specialized area of nursing practice; demonstrate competence in a selected functional role (clinical specialist, nurse practitioner,

nurse administrator, or nurse educator); evaluate and apply research findings from nursing and related disciplines to advanced nursing practice; participate in the development of nursing knowledge by identifying researchable nursing problems, conducting research and selectively integrating research findings in advanced nursing practice; utilize leadership, management, teaching knowledge and competence to influence nursing practice; participate as a leader to influence health policy and improve the health care delivery system; and contribute to the advancement of the nursing profession.

All graduate courses are based at the University Center of Greenville.

Admission Requirements

In addition to meeting University admission requirements, applicants should be graduates of nationally-accredited baccalaureate nursing programs; must have had an undergraduate statistics course, computer course, or equivalent; and must demonstrate evidence of current basic client assessment skills. In addition, students must document recent significant nursing practice which is defined as 600 hours during the 12 months prior to acceptance into the program. Nursing Administration majors must complete an undergraduate accounting course.

PARKS, RECREATION AND TOURISM MANAGEMENT

Master of Science

Doctor of Philosophy

The Department of Parks, Recreation and Tourism Management offers a Master of Science degree (MS thesis and non-thesis) and a Doctor of Philosophy degree (PhD). Flexibility permits individual development in professional interest areas such as therapeutic recreation; travel and tourism management; recreation resource management and interpretation; and community recreation, sport and camp management. Each student's program is tailored to suit his/her personal and professional goals. Applicants from nonrecreation disciplines are required to develop background knowledge of recreation through undergraduate coursework. Applicants for the MS (thesis) and Ph.D must submit GRE scores.

The Master of Science (thesis) degree is designed for individuals planning to undertake doctoral study or seek employment in a research-related position. The Master of Science (non-thesis) degree is designed for practitioners desiring an advanced degree or those looking for a career change but unable or not interested in earning a degree in residence. Candidates who select the thesis option must complete a minimum of 30 hours of coursework and six hours of research culminating in a thesis. Students who select the non-thesis program must complete 27 hours of coursework and a three-hour culminating project. The non-thesis option is delivered entirely online.

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. Coursework is determined by each student's doctoral committee.

COURSES OF INSTRUCTION

This list includes for each course the catalog number, title, credit hours, class and laboratory hours per week, description and prerequisites.

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

Graduate credit may be earned only for courses numbered 600 or above. Each 600-level course carries a 400-level undergraduate counterpart. 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. Students who receive credit for the 400-level course may not receive credit later for the same course at the 600 level.

Courses at the 700 level are designed primarily for the degrees that emphasize professional practice rather than research.

COURSE ABBREVIATIONS

Accounting.....	ACCT
Aerospace Studies	AS
Agricultural Education	AG ED
Agricultural Mechanization and Business.....	AG M
Agriculture	AGRIC
Agriculture, Forestry and Life Sciences.....	AFLS
American Sign Language	A S L
Animal and Veterinary Sciences.....	AVS
Anthropology.....	ANTH
Applied Economics.....	AP EC
Architecture	ARCH
Art	ART
Art and Architectural History	A A H
Astronomy.....	ASTR
Athletic Leadership.....	A L
Automotive Engineering.....	AU E
Biochemistry	BIOCH
Bioengineering.....	BIO E
Biological Sciences	BIOSC
Biology	BIOL
Biomolecular Engineering	BMOLE
Biosystems Engineering	B E
Botany	BOT
Business.....	BUS
Business Administration.....	M B A
Calhoun Honors Seminar	C H S
Career and Technology Education	CTE
Chemical Engineering	CH E
Chemistry.....	CH
Chinese	CHIN
City and Regional Planning.....	C R P
Civil Engineering	C E
Clemson University	C U
College of Engineering and Science.....	CES
Communication Studies.....	COMM
Community and Rural Development.....	C R D
Computer Science.....	CP SC
Construction Science and Management.....	C S M
Crop and Soil Environmental Science.....	CSENV
Dance	DANCE
Design Studies	DSIGN
Digital Production Arts	D P A

Early Childhood Education	ED EC	Packaging Science	PKGSC
East Asian Studies.....	E A S	Pan African Studies	P A S
Economics.....	ECON	Parks, Recreation and Tourism Management...PRTM	
Education.....	ED	Performing Arts	P A
Educational Counseling	ED C	Philosophy.....	PHIL
Educational Foundations	ED F	Physical Science.....	PH SC
Educational Leadership	ED L	Physics	PHYS
Electrical and Computer Engineering.....	E C E	Planning, Design and the Built Environment...PDDE	
Elementary Education	ED EL	Plant and Environmental Sciences.....	PES
Engineering.....	ENGR	Plant Pathology	PL PA
Engineering and Science Education.....	ESED	Plant Physiology	PL PH
Engineering Graphics	E G	Policy Studies	PO ST
Engineering Mechanics.....	E M	Political Science	PO SC
English	ENGL	Portuguese	PORT
Entomology.....	ENT	Psychology	PSYCH
Environmental and Natural Resources	E N R	Public Administration	P ADM
Environmental Engineering and Science.....	EE&S	Real Estate Development.....	RED
Environmental Science and Policy	EN SP	Religion	REL
Environmental Toxicology.....	ENTOX	Rhetorics, Communication and	
Executive Leadership and Entrepreneurship	E L E	Information Design.....	RCID
Experimental Statistics	EX ST	Rural Sociology	R S
Family and Community Studies.....	FCS	Russian	RUSS
Finance.....	FIN	Secondary Education.....	EDSEC
Food Science	FD SC	Sociology	SOC
Food Technology.....	FD TH	Soils and Sustainable Crop Systems.....	SSCS
Forestry	FOR	Spanish	SPAN
Forestry and Natural Resources.....	F N R	Special Education	ED SP
French	FR	Systems Engineering	SYS E
Genetics	GEN	Theatre	THEA
Geography	GEOG	Vocational-Technical Education	VT ED
Geology	GEOL	Wildlife and Fisheries Biology	W FB
German	GER	Women's Studies	W S
Graduate Studies	G S		
Graphic Communications	G C		
Great Works	G W		
Health	HLTH		
Healthcare Genetics	HCG		
Health Administration	M H A		
Health, Education and Human Development	HEHD		
Historic Preservation	H P		
History	HIST		
Horticulture	HORT		
Human Resource Development	H R D		
Humanities	HUM		
Industrial Engineering	I E		
Integrated Pest Management	I P M		
Italian	ITAL		
Japanese	JAPN		
Landscape Architecture	LARCH		
Language	LANG		
Language and International Trade	L & IT		
Latin	LATIN		
Law	LAW		
Leisure Skills	L S		
Library	LIB		
Literacy	EDLT		
Management	MGT		
Marketing	MKT		
Materials Science and Engineering	MS&E		
Mathematical Sciences	MTHSC		
Mechanical Engineering	M E		
Microbiology	MICRO		
Military Leadership	M L		
Music	MUSIC		
Nonprofit Leadership	NPL		
Nursing	NURS		
Nutrition	NUTR		

ACCOUNTING

ACCT 604 Individual Taxation 3(3,0) 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. *Preq:* ACCT 311 with a C or better.

ACCT 610 Budgeting and Executive Control 3(3,0) Study and application of selected techniques used in the planning and control functions of business organizations. *Preq:* ACCT 303 with a C or better.

ACCT 821 Controllership 3(3,0) Advanced internal accounting emphasizing accounting implications for management decision making. *Preq:* ACCT 303 or equivalent.

ACCT 851 Tax Research 3(3,0) 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. *Preq:* ACCT 404 or equivalent.

ACCT 852 Financial Accounting Theory and Research 3(3,0) Evolution of financial accounting theory and its application to contemporary reporting. Emphasis is on learning to research, document and present a rationale for a recommended alternative. Research problems are derived from actual audit disputes concerning financial presentation. *Preq:* ACCT 313 or equivalent.

ACCT 853 Advanced Accounting Problems 3(3,0) Study of specialized aspects of financial reporting, including business combinations, fund accounting and emerging practices and developments in financial accounting. *Preq:* ACCT 313 or equivalent.

ACCT 854 Ethical, Professional and Societal Responsibilities 3(3,0) Study of ethical and societal responsibilities and constraints that define and affect the practice of accountancy. Includes selected readings and cases. *Prerequisite:* ACCT 404 and 415, or equivalent.

ACCT 855 Governmental and Nonprofit Accounting 3(3,0) Provides an in-depth understanding of the unique environment, concepts, and procedures of accounting, financial reporting, auditing, and budgeting of governmental and not-for-profit organizations. *Prerequisite:* ACCT 313 or equivalent.

ACCT 856 CPA Exam Review-A 0 Preparation for the auditing and attestation section of the Certified Public Accountant exam. Must be completed prior to receiving MPAcc degree. Does not contribute hours toward degree completion. To be taken Pass/Fail only. *Prerequisite:* Enrollment in MPAcc program.

ACCT 857 CPA Exam Review-B 0 Preparation for the business environment and concepts section of the Certified Public Accountant exam. Must be completed prior to receiving MPAcc degree. Does not contribute hours toward degree completion. To be taken Pass/Fail only. *Prerequisite:* Enrollment in MPAcc program.

ACCT 858 CPA Exam Review-F 0 Preparation for the financial accounting and reporting section of the Certified Public Accountant exam. Must be completed prior to receiving MPAcc degree. Does not contribute hours toward degree completion. To be taken Pass/Fail only. *Prerequisite:* Enrollment in MPAcc program.

ACCT 859 CPA Exam Review-R 0 Preparation for the regulation section of the Certified Public Accountant exam. Must be completed prior to receiving MPAcc degree. Does not contribute hours toward degree completion. *Prerequisite:* Enrollment in MPAcc program.

ACCT 861 Operational Auditing 3(3,0) Provides in-depth understanding of concepts underlying operational auditing and experience in planning, conducting and reporting in operational auditing using a risk-based, process and controls focused approach. *Prerequisite:* ACCT 415 or equivalent.

ACCT 862 Financial Auditing 3(3,0) Advanced course in financial auditing to provide a framework for thinking about contemporary auditing and assurance issues and evaluating alternative rationales regarding the value and purpose of an audit as well as conducting financial audit research. *Prerequisite:* ACCT 415 or equivalent.

ACCT 863 Forensics and Analysis 3(3,0) Study of financial statement analysis with quality assessments and forensic analysis. Includes forecasting, asset and business valuation approaches and other special topics. *Prerequisite:* ACCT 313 or equivalent.

ACCT 864 Accounting Information Systems 3(3,0) Accounting systems including database concepts, systems design and evaluation, systems controls and systems implementation. *Prerequisite:* ACCT 322 and 415, or equivalent.

ACCT 865 Taxation of Business Decisions 3(3,0) Discusses the interrelationship of taxation and business decisions. Designed for students not specializing in taxation. *Prerequisite:* ACCT 404 or equivalent.

ACCT 871 Federal and State Income Taxation of Corporations 3(3,0) Discusses 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 872 Taxation of Flowthrough Entities 3(3,0) Covers federal income taxation of entities treated as partnerships, S corporations, estates and trusts. *Prerequisite:* ACCT 404 or equivalent.

ACCT 873 International and Special Topics in Taxation 3(3,0) Seminar on international and special topic areas that impact practicing tax professionals. *Prerequisite:* ACCT 404 or equivalent.

ACCT 874 Tax Aspects of Financial Planning 3(3,0) Covers federal estate and gift tax laws; federal income tax laws related to trusts and estates. *Prerequisite:* ACCT 404 or equivalent.

ACCT 875 State, Local and Advanced Topics in Taxation 3(3,0) Explores state and local income taxation issues and planning, retirement plans, deferred compensation plans, IRS practice and procedures and current sophisticated developments in taxation. *Prerequisite:* ACCT 404 or equivalent.

AGRICULTURAL EDUCATION

AG ED 601 Instructional Methods in Agricultural Education 3(2,3) Appropriate methods of teaching vocational agriculture in high schools. Includes procedures for organizing teaching programs, teaching high school students and directing FFA activities.

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

AG ED 615 Leadership of Volunteers 3(3,0) Provides an overview of volunteer management. Examines the knowledge, skills and abilities required of professional managers to involve volunteers effectively in the work of organizations.

AG ED 616 Ethics and Issues in Agriculture and the Food and Fiber System 3(3,0) Explores ethical theories, concepts of critical thinking and major ethical issues in American agriculture. The major social, political, economic and ethical issues that arise in connection to the "food and fiber system" are examined and potential solutions considered.

AG ED 623 Curriculum 3(3,0) Curriculum goals and related planning for career and continuing education programs.

AG ED 625 Teaching Agricultural Mechanics 2(1,3) 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(1-3,0) Students study, individually or collectively, selected topics and/or problems in agricultural education to meet the particular needs of the clientele enrolled. May be repeated for a maximum of six credits.

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

AG ED (CTE, ED F) 680 Digital Technology in the 21st Century Classroom 3(2,2) See ED F 680.

AG ED (CTE, ED F) 682 Advanced Educational Applications of Microcomputers 3(2,2) See ED F 682.

AG ED 736 Internship Teaching 3(1,6) Increases professional competency and program development through classroom and practical experiences in planning, conducting and evaluating educational programs. Offered spring semester only.

AG ED 737 Internship in Agribusiness Firms 3(1,6) Provides 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. Offered summer session only.

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

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

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

AG ED 810 Clinical Research in Agricultural Education 1-6(0,3-18) Individual work on an assigned research topic in agricultural education. May be repeated for a maximum of nine credits. *Prerequisite:* AG ED (CTE, ED) 889, EX ST 801.

AG ED 812 Development of Supervised Agricultural Experience Programs 3(3,0) Provides secondary agriculture teachers with strategies for supervising and guiding students' supervised agricultural experiences (SAE). *Prerequisite:* Student teaching in agricultural education.

AG ED 815 Teaching Agricultural and Power Mechanics 3(2,3) 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. Offered summer session of odd-numbered years only.

AG ED 821 Theories and Practices of Adult Education 3(3,0) Study of recent research on adult learning. Includes a comparison of the assumptions supporting pedagogy and andragogy and teaching adults through formal classes and community organizations. Offered spring semester only. *Prerequisite:* ED 302 or PSYCH 201 or equivalent.

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

AG ED (CTE, ED) 889 Research in Education 3(3,0)
 Includes problem selection. Investigates types of educational research and techniques employed. Includes the use of ERIC system and computer program packages. Requires interpretation of research findings.

AGRICULTURAL MECHANIZATION AND BUSINESS

AG M 602 Landscape Drainage and Irrigation 3(2,3) Uses basic soil-water-plant relationships to determine the need for and methods of irrigation and drainage. Topics include irrigation methods, drainage needs and drainage methods. *Preq or Coreq:* AG M 301 or consent of instructor.

AG M 605 Environmental Control in Animal Structures 3(2,3) Design of environmental control systems for animal production facilities. Topics include effects of the thermal and chemical environment on animals, ventilation system design, thermal design of structural envelopes, design of heating, cooling and lighting systems. Emphasis is on practical, energy-efficient applications to modern animal production facilities. *Preq:* AG M 303 or AVS 301 or consent of instructor.

AG M 606 Mechanical and Hydraulic Systems 3(2,3) Study of power transmission systems for agricultural production with emphasis on mobile equipment. Characteristics, requirements and design of both V-belt drive and roller-chain drives are presented. Emphasizes hydraulic power transmission systems, including pumps, actuators, control devices and hydraulic circuitry. *Preq:* AG M 206, PHYS 200 or 207, or consent of instructor.

AG M 610 Precision Agriculture Technology 3(2,3) Includes principles and hands-on application of technologies supporting precision agriculture. Topics include Global Positioning System (GPS) and Geographic Information System (GIS) software, variable rate technologies, collection of spatial data, automated guidance of equipment, spatial data mapping and analysis, remote sensing and economic considerations. *Preq:* Graduate standing.

AG M 652 Mobile Power 3(2,3) 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. *Preq:* PHYS 200, 207, or consent of instructor.

AG M 660 Electrical Systems 3(2,3) Students in agriculture and related curricula study 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 are emphasized. *Preq:* Junior standing.

AG M 771 Selected Topics in Agricultural Mechanization 1-3(1-3,0) Selected topics not covered in other courses. Performance is measured by oral or written reports or examinations. May be repeated for a maximum of six credits.

AG M 781 Special Problems 1-3(1-3,0) Independent analysis through literature review and laboratory or field research. Requires written documentation. May be repeated for a maximum of six credits.

ANIMAL AND VETERINARY SCIENCES

AVS 610 Domestic Animal Behavior 3(3,0) Provides knowledge and understanding of behavior related to perception, learning, sociality, reproduction, feeding and health for application in production, training and design of environments for optimum health and welfare of domestic animals. *Preq:* AVS 150, 151 and junior standing.

AVS 611 Animal Growth and Development 3(3,0) Integration of the nutritional, physiological and genetic basis for animal growth and development with application to livestock and poultry production. Includes the cellular and molecular mechanisms controlling these processes and emphasizes the genes that regulate animal products (meat, eggs, wool and milk). *Preq:* AVS 301.

AVS 612 Advanced Equine Management 4(3,2) Further discussion of special considerations of the equine regarding housing, manure management, nutrition, reproduction, transportation and behavior. Students gain insight into how horses differ from other livestock species and their unique requirements for the above systems. *Preq:* AVS 370.

AVS 613 Animal Products 3(2,3) Introduction to the safe and humane production of red meat, poultry, and dairy products. Includes HACCP principles and production of value-added animal products.

AVS (BIOSC, MICRO) 614 Basic Immunology 3(3,0) See MICRO 614.

AVS 615 Contemporary Issues in Animal Science 3(3,0) Provides knowledge, understanding and critical analytical skills on current issues in animal agriculture in diverse regional, national and global social-cultural and political environments as they impact animals and man. *Preq:* Junior standing in Animal and Veterinary Sciences.

AVS 616 Equine Exercise Physiology 4(3,2) Integration of muscle, bone, cartilage, cardiovascular, and respiratory systems as related to the equine athlete. Encompasses biomechanics, kinetics, and kinesiology related concepts specific to the horse. Further discussion of diseases related to specific systems is covered. *Preq:* AVS 301.

AVS 617 Animal Agribusiness Development 2(1,2) Team-based development of a business relating to the animal industries. Students develop the business from the initial idea through operations. Focuses on the development of the business plan, including financials, personnel management, and resources needed. *Preq:* ACCT 201 and AP EC 202 or consent of instructor.

AVS 620 Poultry Science On-line 3(3,0) On-line course covering the physiology, nutrition, health, reproduction, genetics, breeding, housing and management of commercial poultry species including the processing of meat and egg products.

AVS 643 AVS International Experience 1-3(1-3,0) Preplanned and approved international education/cultural experience supervised by an Animal and Veterinary Sciences faculty member. Periodic reports or record keeping are required. Final report and oral presentation are required at the end of the experience. May be repeated for a maximum of four credits. To be taken Pass/Fail only. *Preq:* Consent of instructor.

AVS 653 Animal Reproduction 3(2,2) Reproductive physiology and endocrinology of mammals with emphasis on farm animals and frequent reference to reproduction in laboratory animals and humans. *Preq:* AVS 150, 301.

AVS 655 Animal Reproductive Management 2(1,3) Physiology and endocrinology of pregnant and nonpregnant cows are discussed. Emphasis is on methods of artificial insemination, pregnancy detection and computer record keeping for achieving a high level of reproductive efficiency in cattle. *Preq:* AVS 150, 301; AVS 453 (or concurrent enrollment).

AVS 665 Animal Physiology I 3(3,0) Advanced study of the physiological systems of domestic animals as these systems relate to the integrated functions of the body. Exposes students to advanced physiological concepts and current literature perspectives on a variety of body systems and processes. *Preq:* Introductory physiology and biochemistry.

AVS 667 Animal Physiology II 3(3,0) Advanced course extending coverage of major and current topics in animal physiology across species not previously covered in AVS 465. Major topics include digestive physiology in nonruminant and ruminant species, reproductive physiology, muscle physiology and general aspects of avian physiology. *Preq:* Introductory course in physiology and biochemistry.

AVS 670 Animal Genetics 3(3,0) Fundamental principles relating to the breeding and improvement of livestock including variation, heredity, selection, linebreeding, inbreeding, crossbreeding and other related subjects. *Preq:* AVS 150.

AVS (BIOSC) 680 Vertebrate Endocrinology 3(3,0) See BIOSC 680.

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

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

AVS 808 Monogastric Nutrition 3(3,0) Basic concepts and current research related to nutrient requirement and metabolism of poultry, swine and other monogastric species. *Preq:* NUTR 401 or 451.

AVS 809 Ruminant Nutrition 3(3,0) Microbiological, biochemical and physiological processes involved in the synthesis of amino acids, proteins and B-vitamins; relation of these processes to utilization of proteins, lipids, and fibrous and nonfibrous feed ingredients; properties and functions of nutrients, nonprotein nitrogen compounds and growth-promoting substances for dairy cattle, beef cattle and sheep. *Preq:* NUTR 401 or consent of instructor.

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

AVS 821 Nutritional Bioenergetics 2(2,0) Quantitative approach to the losses of dietary energy during digestion and metabolism; factors governing the energetic efficiency of different biological functions in animals and man; regulation of energy balance; body temperature regulation; techniques of calorimetry. *Preq:* BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or consent of instructor.

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

AVS 825 Immunobiology 3(3,0) Conceptual approach to immunobiology emphasizing the molecular and cellular aspects. Classical and current literature is the major source for the discussion/lecture format. Offered spring semester only. *Preq:* Consent of instructor.

AVS 891 Master's Thesis Research 1-12

AVS 991 Doctoral Dissertation Research 1-12

ANTHROPOLOGY

ANTH 603 Qualitative Methods 3(3,0) Methods and techniques of qualitative field research including participant observation, ethnographic interviewing, data analysis and report writing. *Preq:* ANTH 201 or consent of instructor.

ANTH (W S) 623 Women in the Developing World 3(3,0) Comparative anthropological study of women and their status in developing countries around the world. A survey of women's daily lives in a global context, emphasizing education, economics, and the environment. Case studies include microfinance, literacy, reproductive rights and practices, and the impact of religious fundamentalism on women. *Preq:* Sophomore standing.

ANTH (BIOSC) 674 Primatology 4(3,3) See BIOSC 674.

APPLIED ECONOMICS

AP EC 602 Production Economics 3(3,0) Economic analysis of agricultural production involving the concept of the farm as a firm, principles for decision making, the quantitative nature and use of production and cost functions and their interrelations, and application of these principles to resource allocation in farms and among areas. Offered fall semester only. *Preq:* AP EC 308, ECON 314.

AP EC 609 Commodity Futures Markets 3(3,0) Introduction to the economic theory, organization and operating principles of agricultural commodity futures markets in the United States. Emphasis is placed on speculating, hedging and investing in agricultural commodity futures contracts from the standpoint of the agribusiness entrepreneur. *Preq:* AP EC 202 or ECON 211.

AP EC (C R D) 611 Regional Impact Analysis 3(3,0) See C R D 611.

AP EC (C R D) 612 Regional Economic Development Theory and Policy 3(3,0) See C R D 612.

AP EC 613 Advanced Real Estate Appraisal 3(3,0) Topics include highest and best use analysis, data collection and analyses. Advanced appraisal procedures for income, cost and comparable sales approach to real estate valuation are stressed. Eminent domain, the appraisal of property in transition and specialized property are covered. Offered spring semester only. *Preq:* AP EC 313, FIN 307, or consent of instructor.

AP EC 621 Globalization 3(3,0) Utilizes basic principles of international economics (comparative advantage, free trade vs. protectionism, exchange rate determination, etc.) to analyze the contemporary problems and issues of the world economy. Emphasizes application of economic principles to current globalization trends. *Preq:* ECON 310 or 412 or 413 or consent of instructor.

AP EC (CSENV) 626 Cropping Systems Analysis 3(2,2) See CSENV 626.

AP EC 652 Agricultural Policy 3(3,0) Review of public agricultural policy programs in the United States and a critical examination of current and proposed government policies and programs affecting the agricultural sector of the economy. Includes economic considerations as related to past and current farm price and income problems. Offered spring semester only. *Preq:* AP EC 302, 309.

AP EC 656 Prices 3(3,0) Review of the 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. Offered spring semester only. *Preq:* AP EC 308, ECON 314, EX ST 462.

AP EC (ECON) 657 Natural Resource Use, Technology and Policy 3(3,0) Focuses on economic analyses of actual, efficient and sustainable uses of natural resources, impacts of technologies that affect these uses and policies that affect development and use of such technologies. Resource-technology-policy combinations may vary, but an example is crude oil, hybrid automotive engines and fuel economy standards. *Preq:* MTHSC 102 and either C R D (AP EC) 357 or ECON 314 or consent of instructor.

AP EC 660 Agricultural Finance 3(3,0) Study of the principles and techniques of financing in the agricultural sector. Topics include the capital situation in agriculture, concepts of farm financial management, use of credit, capital markets, lending agencies and estate planning. Offered spring semester only. *Preq:* ACCT 201, AP EC 202.

AP EC 675 Economics of Wildlife Management and Policy 3(3,0) Integrated approach to the study of the economics of wildlife. Topics include determination of market and nonmarket value, single and multiple species management, enterprise cost and returns, marketing wildlife, leasing methods, complementarity and competitiveness with agricultural and forestry enterprises and timber and crop damage cost estimates and control. *Preq:* AP EC 202, ECON 200, FOR 304, W F B 306, or consent of instructor.

AP EC (ECON) 800 History of Economic Thought 3(3,0) See ECON 800.

AP EC (ECON) 801 Microeconomic Theory 3(3,0) See ECON 801.

AP EC (ECON) 802 Advanced Economic Concepts and Applications 3(3,0) See ECON 802.

AP EC (ECON) 804 Applied Mathematical Economics 3(3,0) Discusses mathematical tools needed in economic analysis; matrix algebra, differentiation, unconstrained and constrained optimization, integration and linear programming.

AP EC (ECON) 806 Econometrics I 3(3,0) Application of econometric techniques and stochastic models to economic problems. Considers distribution theory, simple and multiple regression modeling, hypothesis testing and other issues in regression analysis.

AP EC (ECON) 808 Econometrics III 3(3,0) See ECON 808.

AP EC (ECON) 809 Advanced Natural Resource Economics 3(3,0) 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. Offered spring semester only. *Preq:* ECON (AP EC) 801 or consent of instructor.

AP EC (ECON) 810 Natural Resources Management and Policy 3(3,0) 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 is not necessary. Offered fall semester only. *Preq:* Consent of instructor.

AP EC (ECON) 811 Economics of Environmental Quality 3(3,0) See ECON 811.

AP EC 813 Water Resource Economics 3(3,0) Discusses benefit-cost analysis of public water development programs, economic analysis of selected water allocation issues, groundwater management, pollution abatement, efficient pricing and valuation, multiple use management, reservoir management, wetland protection, minimum stream flows for endangered species and environmental and developmental trade-offs. *Preq:* AP EC (ECON) 822 and ECON 823, or consent of instructor.

AP EC (ECON) 816 Labor Economics 3(3,0) See ECON 816.

AP EC (ECON) 817 Advanced Production Economics 3(3,0) Discusses production economics theory in a quantitative framework; technical and economic factor-product, factor-factor, and product-product relationships in single- and multi-product firms under conditions of perfect and imperfect competition in both factor and product markets. Offered spring semester only. *Preq:* AP EC (ECON) 804 or consent of instructor.

AP EC 819 Futures and Options Markets 3(3,0) Introduction to the economic theory and operation of futures and options markets in the United States. Includes determination of prices and price differences, speculation and the use of these markets for forward pricing and price risk management. *Preq:* Consent of instructor.

AP EC (ECON) 820 Public Finance 3(3,0) See ECON 820.

AP EC (ECON) 822 Public Policy Economics 3(3,0)

Covers contemporary public policy, including price and resource policy, affecting rural areas. Discusses public participation, or the lack thereof, related to programs designed to implement public policy. Offered spring semester only. *Preq:* ECON 314 or equivalent and knowledge of first-year calculus, or consent of instructor.

AP EC (ECON) 824 Organization of Industry 3(3,0)
See ECON 824.**AP EC (ECON) 826 Economic Theory of Government Regulation 3(3,0)** See ECON 826.**AP EC (ECON) 827 Economics of Property Rights 3(3,0)** See ECON 827.**AP EC (ECON) 828 Applied Demand Analysis 3(3,0)** Analysis of demand by individual households and consumers in aggregate. Modern approaches to estimation of demand systems and valuation methods. *Preq:* AP EC (ECON) 801 or consent of instructor.**AP EC (ECON) 831 Economic Development 3(3,0)**
See ECON 831.**AP EC (ECON) 832 Community and Regional Economics 3(3,0)** Covers 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. Offered fall semester only. *Preq:* C R D (AP EC) 612 or consent of instructor.**AP EC 836 Dynamic Optimization with Economic Applications 3(3,0)** Dynamic optimization entails the use of optimal control to solve minimization or maximization problems in which choice variables affect how state variables change over time. Differential or difference equations describe the temporal changes. Economic applications pertain to actual use and efficient management over time of financial, human, physical and natural capital. *Preq:* Applied mathematical economics or multivariable calculus or consent of instructor.**AP EC (ECON) 840 International Trade Theory 3(3,0)** See ECON 840.**AP EC (ECON) 841 International Finance 3(3,0)**
See ECON 841.**AP EC (ECON) 855 Financial Economics 3(3,0)**
See ECON 855.**AP EC 881 Internship in Community and Resource Development 1-6** Supervised employment in an agency dealing with socioeconomic aspects, community development and/or natural resource management. Monthly reports covering the student's experience are required. *Preq:* 18 semester hours of graduate credit.**AP EC 891 Master's Thesis Research 1-12****AP EC 899 Selected Topics 1-3(1-3,0)** Selected topics under the guidance of a professor. May be repeated for a maximum of six credits.**AP EC (ECON) 901 Price Theory 3(3,0)** See ECON 901.**AP EC 903 General Equilibrium and Welfare Theory 3(3,0)** Second in a two-course sequence in advanced price theory covering the capital theory and the determination of the rate of interest. Offered spring only. *Preq:* ECON (AP EC) 901.**AP EC (ECON) 904 Seminar in Resource Economics 3(3,0)** Special problems and recent periodical literature relating to the control, management, development, and use of land and water resources in the U.S. and in other parts of the world. Offered fall semester only. *Preq:* AP EC 603.**AP EC (ECON) 906 Seminar in Area Economic Development 3(3,0)** Consideration of recent research developments in economic development. Includes a review of research publications, journal articles and other literature. Objectives, analytical techniques and procedures are used in area or regional development efforts. Offered spring semester only. *Preq:* AP EC (ECON) 806.**AP EC (ECON) 917 Advanced Seminar in Labor Economics 3(3,0)** See ECON 917.**AP EC (ECON) 950 Monetary Economics 3(3,0)** See ECON 950.**AP EC (ECON) 991 Doctoral Dissertation Research 1-12****ARCHITECTURE****ARCH 605 American Architectural Styles 1650-1950 3(3,0)** 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(3,0)** Directed investigations related to the art and architectural history of Europe. May be repeated for a maximum of six credits. *Preq:* Junior standing or consent of instructor.**ARCH 614 Design Seminar 3(3,0)** Exploration of topical issues in architecture, art, construction and planning. May be repeated for a maximum of six credits. *Preq:* Junior standing or consent of instructor.**ARCH 616 Field Studies in Architecture and Related Arts 3(0,9)** Documentation and analysis of architectural structures observed during European travels in graphic and written form. May be repeated for a maximum of six credits. *Preq:* Junior standing or consent of instructor.**ARCH 624 Product Design 3(0,9)** Furniture and product system design with emphasis on ergonomics and the relationship of form and materials. *Preq:* Senior standing and consent of instructor.**ARCH 625 Energy in Architecture 3(3,0)** Climate design methodology and its influence on building energy patterns and architectural form. *Preq:* Senior standing and consent of instructor.**ARCH 626 Architectural Color Graphics 3(3,0)** Architectural color graphics by computer. Theories of color classification and interaction; application of color theories to art and architecture. *Preq:* Consent of instructor.**ARCH 627 Advanced Color Graphics 3(3,0)** Theories of color classification and interaction; three-dimensional color modeling by computer; advanced application of color theories to art and architecture. *Preq:* ARCH 426 or consent of instructor.**ARCH 628 Computer-Aided Design 3(2,3)** Introduction to the concepts, skills and applications of computer-aided design as they relate to the practice of architecture. *Preq:* Senior standing or consent of instructor.**ARCH 629 Architectural Graphics 3(3,0)** Provides students with an understanding of concepts, skills, techniques and strategies of visual presentation/graphics as they relate to the design professions—architects/landscape architects. *Preq:* Graduate standing or consent of instructor.**ARCH 630 Theories and Philosophies of Technology and Architecture 3(3,0)** 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 640 New York Field Study 3(3,0)** Study of architecture, art, planning and urban design of New York. Two weeks' residence are required with scheduled field trips to relevant sites in all five boroughs, with counseling to determine research interests. Guidance is provided to resources in the city. A final report is required. Offered in the summer only.**ARCH 677 Introduction of Craft 1-3(0,2-6)** Architectural craft lab offered under different material specializations, all of which introduce students to design as informed by craft through a hands-on lab. Basic craft operations and material properties are introduced for the subject material (wood, steel, etc.) May be repeated for a maximum of six credits. *Preq:* Consent of instructor.**ARCH 685 History and Theory of Architecture + Health 3(3,0)** Introduces relationships between health and architectural settings for health. Examines connections between cultural context, medical thought, health-care delivery and health facility design within different time periods. Introduces contemporary theories on the relationships between human beings, their health and well-being and the design of the physical environment. *Preq:* Consent of instructor.**ARCH 688 Architectural Programming and Pre-design 3(3,0)** Introduces the theory, mechanics and practice of architectural programming and post-occupancy evaluation. Presents programming as a means to create architectural settings sensitive to the needs of their inhabitants. Emphasizes collaborative methodologies that involve identifying relevant goals, facts, issues, needs and concepts. Students develop an architectural program. *Preq:* Consent of instructor.**ARCH 699 Selected Topics in Architecture 1-3(1-3,0)** Study of selected topics in architecture. May be repeated for a maximum of nine credits, but only if different topics are covered. *Preq:* Junior standing or consent of instructor.**ARCH 801 Architecture Seminar 3(3,0)** Contemporary issues in the architectural profession.**ARCH 803 Theories of Architecture 3(3,0)** 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.

ARCH 804 Seminar in Modern Masters 3(3,0) In-depth examination of one or more related groups of architects from the 20th century (Kahn, Scarpa, Barrigan, Wright, Corbusier, etc.). Content varies from semester to semester. *Preq:* ARCH 861 or equivalent.

ARCH 810 Visualization and Representation I 3(3,0) Develops students' capacity for graphic representation of architectural form and space. Intended as a corollary to ARCH 840; provides the tools necessary to analyze and translate concepts into two-dimensional constructions through the utilization of manual and digital drawing techniques. *Coreq:* ARCH 840.

ARCH 811 Visualization and Representation II 3(3,0) Develops and improves student's capacity for the digital and graphic representation of three-dimensional architectural form and space. Introduces and explores the latest technologies—from advanced digital modeling tools to equipment for computer-controlled fabrication. *Preq:* ARCH 810 or equivalent or consent of instructor.

ARCH 812 Computational Design Methods 3(3,0) Examines computing in architecture, particularly through the use of parametric and generative systems. Students learn how to structure and process information to communicate and enhance the design process. *Preq:* ARCH 811 or consent of instructor.

ARCH 819 Selected Topics in Visualization and Representation 1-5(1-5,0) Critical consideration of a special topic in architectural visualization and representation from which students construct their own informed and reasoned ideas about what this topic means for their own developing architectural practices. May be repeated for a maximum of six credits. *Preq:* ARCH 810 or equivalent or consent of instructor.

ARCH 820 Building Design and Construction Principles 3(3,0) Essential principles for quality design and construction. Emphasis is on design, programming and sustainability issues for different project types. Nature and characteristics of construction materials, equipment and systems used in modern buildings are presented as well as how they affect function and feasibility. *Preq:* Consent of instructor.

ARCH 821 Research Methods 3(3,0) Covers foundations and procedures of architectural research. Explores alternate research methodologies and their philosophical and epistemological limits.

ARCH 832 Community 1:1 3(3,0) Engages full-scale design projects and initiatives that are community-based and offer opportunities in field research, studio design-centric problems, and documentation. Projects focus on sustainable and sinuous public space and how design and planning can improve the interface between the built and natural environment while enhancing the human experience. *Preq:* ARCH 852 or consent of instructor.

ARCH 840 Design Studio 6(0,12) Studio for students entering the Master of Architecture program with undergraduate degrees in subjects other than Architecture or Environmental Design. Considers aspects of visualization and representation of architecture, the history and theory of architecture, architectural technology and strategies of design. *Coreq:* ARCH 810.

ARCH 841 Architecture Studio I 6(0,12) Studio course focused on increasingly complex works of architecture at various scales for different physical site conditions. *Preq:* ARCH 810 or equivalent.

ARCH 842 Architecture Studio II 6(0,12) Studio course focused on architectural materials and assembly. Course is comprised of architectural design explorations of increasing complexity. Students develop a detailed sectional model of their design proposal. *Preq:* ARCH 841.

ARCH 850 Architecture Studio 6(0,18) Architectural design studies in the context of the Genoa urban setting. May substitute for ARCH 853 or 854 and for ARCH 857 with consent of advisor.

ARCH 851 Design Studio III 6(0,12) Design studio for projects of relative complexity, with varied scales and programs, focusing on investigative skills, fundamental design skills, sustainability, and technical documentation. Emphasizes the relationship between architecture, site, and context in preparation for more advanced design projects and off-campus study. *Preq:* ARCH 841 and 842 or equivalent.

ARCH 852 Design Studio IV 6(0,12) Design studio for projects of relative complexity, with varied scales and programs, with an emphasis on pre-design, sustainability, site design, and collaborative processes. Emphasizes the relationship between architecture, site, and context. Studio may be located in Clemson, Charleston, Barcelona, or Genoa. *Preq:* ARCH 851.

ARCH 855 Studio South 6(0,12) Addresses architectural problems with varied scales and programs in the context of the South. Emphasizes the relationship between architecture, community and context. Projects involve collaboration with other disciplines in the studio to result in architectural solutions for the built environment. Design problems vary according to current issues in the South. May be repeated for a maximum of 12 credits. *Preq:* ARCH 842 or consent of program coordinator.

ARCH 857 Design Studio V 6(0,18) Design studio for increasingly comprehensive design projects, with varied scales and programs, with an emphasis on pre-design, site design, sustainability, and collaborative processes. Emphasizes the relationship between architecture, site, and context. Studio may be located in Clemson, Charleston, Barcelona, or Genoa. *Preq:* ARCH 852.

ARCH 858 Thesis Research 3(0,9) Architectural predesign inventory and analysis for the thesis project. *Preq:* ARCH 854.

ARCH 859 Thesis Manuscript 1-3(0,3-9) Architectural predesign synthesis of research for the thesis project. *Preq:* ARCH 858.

ARCH 860 Architectural History and Theory I 3(3,0) Overview of architecture and urbanism from the Renaissance to the Industrial Revolution, emphasizing the trajectory of western modernity, historical transformations of architectural practices, and the theoretical, philosophical and cultural foundations of changing design approaches. Close readings of primary and secondary sources are complemented by analytical studies of noteworthy precedents.

ARCH 861 Architectural History and Theory II 3(3,0) Study of architecture and urbanism from 1850 to 1950 through thematic investigations, historical narratives and social critiques in order to reveal past theorists' and practitioners' responses to those cultural and technological changes that remain similar today. Close readings of primary and secondary sources complement analytical studies of noteworthy precedents. *Preq:* ARCH 860.

ARCH 862 Architectural History and Theory III 3(3,0) Study of architecture and urbanism from 1950, emphasizing challenges to early twentieth century modernism, the emergence of new urban, suburban, ecological, cultural and technological sensibilities, and the roots of contemporary architecture. Close readings of primary and secondary sources complement analytical studies of noteworthy precedents. *Preq:* ARCH 861.

ARCH 863 History and Theory of Landscape and Urbanism 3(3,0) Cultivates different ways of seeing, representing and understanding the landscape and the city. Both landscape and city are viewed as dynamic, living systems evolving from Roman, Medieval, Baroque, Industrial, Idealized and non-Western roots and shaped by political, economic, social, cultural and physical intentions and incidents.

ARCH 864 Architectural History and Theory IV 3(3,0) Investigation of emerging architectural trends and urban phenomena prepares students for advanced history/theory electives, independent research and architectural practice in the decades ahead through the study of such topics as globalization and non-western architecture, mega-cities, sprawl and urbanization, energy and infrastructure, landscape and urban design, science and sustainability. *Preq:* ARCH 862.

ARCH (E C E) 868 Architectural Robotics 3(3,0)
See E C E 868.

ARCH 869 Selected Topics in History, Theory and Criticism 1-5(1-5,0) Critical consideration of special topics in architectural history, theory and criticism from which students construct their own informed and reasoned ideas about what the topic means for their own developing architectural practices. May be repeated for a maximum of six credits. *Preq:* ARCH 860 and 861 or equivalent.

ARCH 870 Structures I 3(3,0) Forces and their applications to statically determinant structural components and systems such as shear, moment and other stress strain patterns are explored in multiple structural materials. *Preq:* PHYS 208/210 or equivalent.

ARCH 871 Structures II 3(3,0) Addresses advanced topics in structures, exterior envelopes and contemporary production technologies. Continues the exploration of structural elements and systems, expanding to include more complex determinant, indeterminate, long-span and high-rise systems. *Preq:* ARCH 870.

ARCH 872 Productions and Assemblies 3(3,2)
Overview of traditional and contemporary materials and methods of construction. Combines lectures with hands-on lab experience to examine traditional and contemporary modes of construction, their selection, impact and reuse.

ARCH 873 Environmental Systems 3(3,2) Examines in detail the relationship between human comfort and the design of building envelopes and environmental systems. Covers the evolution of contemporary environmental systems and their appropriate application and integration with other design issues.

ARCH 874 Building Processes: Technical Resolution 3(1,3) Develops the designer's ability to assess, select and conceptually integrate structural systems, building envelope systems, environmental systems, life-safety systems and building service systems in a sustainable building design.

ARCH 875 Construction and Building Systems 3(3,0) Sets a standard level of building technology preparation for entering graduate Architecture students who have an undergraduate architectural degree that included courses in architectural technology. Main focus is on analyzing how construction and building systems contribute to architectural design.

ARCH 876 Smart Materials and Kinetic Structures 3(3,0) Study of adaptive and kinetic systems and structures in architecture using smart and emergent materials. Explores the materials, methods and means for buildings to transform and adjust to different functions or climatic conditions and allow various performances. *Preq:* Consent of instructor.

ARCH 878 Lighting for Architecture 3(3,0) Studies interrelationships among the fields that constitute lighting and impact on building form, materials and spatial use. Also considers contributions of daylight and electric light to human response and performance. *Preq:* Consent of instructor.

ARCH 879 Selected Topics in Architectural Technology 1-5(1-5,0) Critical consideration of special topics in architectural technology from which students construct their own informed and reasoned ideas about what the topic means for their own developing architectural practices. May be repeated for a maximum of six credits.

ARCH 881 Professional Practice Survey 3(3,0) Provides an understanding of the basic principles and legal aspects of architectural practice organization: financial management; risk mitigation and arbitration; business planning; time, project and personnel management; client, owner and user needs; selecting consultants; project delivery methods; internship, licensure and registration; professional leadership; ethical standards; and expanding practice settings.

ARCH 882 Building Economics, Costs and Legal Issues 3(3,0) Explores economic factors determining materials, building components and methods of construction. Legal aspects of design are discussed in the context of building cost. *Preq:* ARCH 881 or consent of instructor.

ARCH 886 Health Facilities Planning and Design 3(3,0) Current planning and design considerations for healthcare facilities. Conducted as a series of professional seminars examining overall infrastructural planning and design considerations and detailed considerations for specific areas in hospitals. Topics are covered by Architecture + Health faculty and nationally recognized practitioners. Coreq: ARCH 887.

ARCH 889 Mentorship 1-6 Mentorship in professional practice. Paid work/study in a variety of related disciplines provides students with hands-on experience in design and fabrication fields relevant to the environmental design professions. Consists of two parts: a professional component, managed by an approved sponsor and an academic component, taught by the instructor. May be repeated for a maximum of 18 credits. *Preq:* Consent of instructor and acceptance by sponsor.

ARCH 890 Directed Studies 1-5(1-5,0) Special topics in architecture undertaken on an individual basis with faculty guidance. *Preq:* Consent of advisor.

ARCH 891 Thesis Project 3-9(0,9-27) Complex architectural project emphasizing design exploration and independent work. To be taken Pass/Fail only. *Preq:* ARCH 857, 858.

ARCH 892 Comprehensive Studio 6(0,18) Architectural design studies addressing comprehensive building projects. Topics include site design, programming, building systems design and materials selection. Final product is a complete building design with detailed drawings and models. *Preq:* ARCH 857.

ARCH 893 Synthesis Studio 6(0,12) Studio themes and programs, defined by individual critics, carry an educational objective and present an opportunity for the critic to develop with his/her students a specific area of work or research. Culminates in a comprehensive proposal. *Preq:* Second-year studio.

ARCH 894 Research Studio 6(0,12) Themes and programs, defined by individual critics, carry an educational objective and present an opportunity for the critic to develop with his/her students a specific area of work or research. *Preq:* ARCH 893.

ARCH 895 Architecture + Health Studio: Selected Projects 3-6(0,6-12) Studio for students in Architecture + Health Concentration offering selected projects engaging a variety of health-related topics from health community design, sustainable/green architecture, long-term care and community healthcare projects associated with health and wellbeing. Projects executed are similar to professional practice, combining teamwork with individual design alternatives. May be repeated for a maximum of 12 credits. *Preq:* Consent of instructor.

ARCH 896 Architecture + Health Studio: Tectonic Projects 6(0,12) Studio for students in Architecture + Health Concentration focused on the design and technical development of small-scale healthcare projects and spaces. Projects are often conducted by interdisciplinary teams as design-build projects where full-scale mock ups are conceived and constructed for evaluation and research. May be repeated for a maximum of 12 credits. *Preq:* Consent of instructor.

ARCH 897 Architecture + Health Studio: Hospital and Urban Design 3-6(0,6-12) Studio course for students in Architecture + Health Concentration, focused on the master planning and conceptual design of an academic medical center or hospital within an urban context. The master planning and design problem is preceded by a comparative analysis of both urban structures and hospital structures. May be repeated for a maximum of 12 credits. Coreq: ARCH 886.

ART

ART 605 Advanced Drawing 3(0,6) 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. *Preq:* ART 305 or consent of instructor.

ART 607 Advanced Painting 3(0,6) Advanced studio course in painting. Study of contemporary painters and directions is included. Students select painting media and are expected to develop a strong direction based on prior painting experience. *Preq:* ART 307 or consent of instructor.

ART 609 Advanced Sculpture 3(0,6) 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. *Preq:* ART 309 or consent of instructor.

ART 611 Advanced Printmaking 3(0,6) 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. *Preq:* ART 311 or consent of instructor.

ART 613 Advanced Photography 3(0,6) Continuation of ART 313. Advanced problems in photography. *Preq:* ART 313 or consent of instructor.

ART 617 Advanced Ceramic Arts 3(0,6) Students are directed toward further development of ideas and skills. Glaze calculation and firing processes are incorporated to allow for a dynamic integration of form and ideas. *Preq:* ART 317 or consent of instructor.

ART 620 Selected Topics in Art 1-3(0,6-9) Intense course in studio art. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* Senior standing or consent of instructor.

ART 690 Directed Studies 1-5(0,2-10) Study of areas in the visual arts not included in other courses or additional advanced work. Must be arranged with a specific instructor prior to registration. May be repeated for a maximum of 18 credits. *Preq:* Consent of instructor.

ART 803 Fundamentals of Visual Art 3(0,6) Intensive introduction of visual art and design fundamentals. Includes 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(3,0) 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(3,0) Continuation of ART 805.

ART 813 Photo-Based Imaging Theories and Techniques 3(0,6) Offers in-depth examination of photographic imaging processes for artistic expression, utilizing both traditional and digital tools and concepts. *Preq:* Master of Fine Arts student or consent of instructor.

ART 821 Visual Narrative 3(3,0) Students develop visual communication skills through the vernacular of cinema, and express concepts and ideas in sequential narrative design. *Preq:* Consent of instructor.

ART 840 Visual Arts Studio 3-6(0,9-18) 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(0,9) Concentrated and advanced work in ceramics, drawing, painting, printmaking, sculpture, photography, graphic design, or multimedia. *Preq:* Consent of department chair or instructor.

ART 851 Visual Arts Studio 3-6 Continuation of ART 850. May be repeated for maximum of six credits. *Preq:* Consent of department chair or instructor.

ART 870 Visual Arts Studio 6(0,16) Advanced theory; directed research in art criticism; applied work in ceramic arts, drawing, painting, sculpture, photography, graphic design, or multimedia. *Preq:* Consent of department chair or instructor.

ART 871 Visual Arts Studio 3-6(0,8-16) Continuation of ART 870. May be repeated for maximum of six credits. *Preq:* Consent of department chair or instructor.

ART 880 Visual Arts Studio 3-15(0,6-30) Continuation of ART 871. May be repeated for maximum of 15 credits. *Preq:* Consent of department chair or instructor.

ART 891 Master's Thesis Research 3-15(0,6-30) May be repeated for maximum of 15 credits. *Preq:* Consent of department chair or instructor.

ART AND ARCHITECTURAL HISTORY

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

A A H 623 Studies in the Art and Architecture of the Renaissance I 3(3,0) Consideration of the visual arts and architectural monuments of the Renaissance (Western Europe from the 15th-18th centuries), with a study in depth of selected examples from the period. *Preq:* A A H 204 or 206 or consent of instructor.

A A H 624 Studies in the Art and Architecture of the Renaissance II 3(3,0) Consideration of the visual arts and architectural monuments of the Renaissance (Western Europe from the 15th-18th centuries), with a study in depth of selected examples from the period. *Preq:* A A H 423.

A A H 630 Twentieth Century Art I 3(3,0) Acquaints students with the major artists' monuments and issues of the Modern period in art. Through lecture/discussions and the reading of primary sources, course places the major modern movements in the context of the period (1860s-1945). *Preq:* Consent of instructor.

A A H 632 Twentieth Century Art II 3(3,0) Overview of trends in art and architecture since World War II. Specific artists, artworks and movements are presented in a socio/historic context with specific emphasis on the transition from a late-modernist to a post-modern perspective. *Preq:* Consent of instructor.

A A H 815 Art and Architectural History Seminar I 3(3,0) Particular aspect of period of art/architectural history. *Preq:* Consent of instructor.

A A H 816 Art and Architectural History Seminar II 3(3,0) Continuation of A A H 815.

A A H (COMM, ENGL) 840 Selected Topics 3(3,0) See ENGL 840.

ASTRONOMY

ASTR 802 Stellar Structure and Evolution 3(3,0) 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. *Preq:* PHYS 455 or equivalent or consent of instructor.

ASTR 803 Galactic Structure 3(3,0) 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. *Preq:* Consent of instructor.

ASTR 810 Astrophysics I: Radiation Processes and Measurements 3(3,0) Physical principles governing radiative processes in and measuring radiation from astrophysical environments. Coverage includes approaches to radiative transfer, fundamental theory of radiation fields, emission and absorption processes, plasma effects, telescope optics and image formation, astronomical instrument design, photon detector and function. *Preq:* Consent of instructor.

ASTR 820 Astrophysics II: Stellar Astrophysics 3(3,0) Physical and observational parameterization of stars, statistical mechanics and equations of state applied to stellar interiors, stellar energy transport mechanisms, nuclear reactions in astrophysics, construction of stellar models, adiabatic stellar pulsations, stellar evolution and nucleosynthesis, degenerate stars, and supernovae. *Preq:* Consent of instructor.

ASTR 830 Astrophysics III: Galactic Astronomy 3(3,0) Physical processes in the interstellar medium, physics of dust grains, physical models of and observational constraints on star formation and protostellar evolution and protoplanetary disks, (thermo)dynamics of stellar systems, models of galaxy formation, the Milky Way as a galaxy, stellar populations, galactic dynamics and chemical evolution. *Preq:* Consent of instructor.

ASTR 840 Astrophysics IV: Cosmology 3(3,0) Course covers galaxies and cosmology. Topics include observed cosmological properties of the universe, physics and observed properties of active galactic nuclei and quasars and their use as cosmological probes, cosmological models, galaxy formation and evolution, large-scale structure in the universe, and primordial nucleosynthesis. *Preq:* Consent of instructor.

ASTR 875 Selected Topics 1-3(1-3,0) Study of one or more advanced topics in contemporary astrophysics. May be repeated for credit, but only if different topics are covered. *Preq:* Consent of instructor.

ATHLETIC LEADERSHIP

A L 653 Athletic Injuries: Prevention, Assessment and Rehabilitation 3(3,0) Gives students an understanding of prevention, treatment and rehabilitation procedures of injured athletes. *Preq:* A L 349.

A L 849 Athletic Leadership Development 3(3,0) Investigation of leadership principles and theories as they relate to collegiate athletic coaching and the effect they have on the performance of the collegiate academic athlete. Collegiate coaching responsibilities and requirements for various levels of appointment are examined. *Preq:* Consent of instructor.

A L 861 Athletic Leadership for Intercollegiate Administration 3(3,0) Investigates effective leadership principles and theories relative to the supervision and administrative responsibilities of intercollegiate athletics. *Preq:* Consent of instructor.

A L 862 Psychological Issues in Collegiate Athletics 3(3,0) Investigation and intervention of psychological issues that athletes, coaches and administrators face at the collegiate level. *Preq:* Consent of instructor.

A L 864 Ethical Issues in Collegiate Athletic Administration 3(3,0) Investigation of current ethical issues and the promotion of positive character development in collegiate athletic programs. *Preq:* Consent of instructor.

AUTOMOTIVE ENGINEERING

AU E 805 Ground Vehicle Aerodynamics 3(3,0) Basic and applied aspects of aerodynamics relevant for internal and external design for performance, including drag, handling, noise and ventilation. Wind tunnel and track testing methods and computational modeling approaches are utilized.

AU E 816 Engine Combustion and Emissions 3(2,3) Spark and compression ignition engines are investigated in terms of design, performance and emissions. Includes exergy models. Integrates theory of fuel air cycles with laboratory breakdown and dynamometer testing to correlate prevalent mathematic models with test results.

AU E 817 Alternative Energy Sources 3(3,0) Demand for petroleum alternative propulsion sources has focused attention on hybrid vehicles with fuel cells, electric motors and battery packs and internal combustion engines burning hydrogen and reformulated fuels. Comparison of performance, emissions, fuel efficiency, operational requirements and vehicle configurations is studied.

AU E 825 Automotive Sensors and Actuators 3(3,0) Study of automotive sensor and actuator requirements, design and selections as well as future needs. Sensor and actuator networks, noise and interference issues, wired and wireless systems are examined as well as integrated smart sensors and actuators with applications to traditional and intelligent vehicle systems.

AU E 826 On-Board Vehicle Diagnostics and Reliability 3(3,0) Discussion of legislated state, federal and international requirements. On-board automotive sensors to monitor vehicle operation and typical diagnostic algorithms are studied. Includes analytical methods for designing fault-tolerant systems and assessing vehicle reliability including safety-critical systems and “limp-home” modes, as well as use of hand-held scanners and specialized diagnostic equipment to classify faults.

AU E 827 Automotive Control Systems Design 3(3,0) Investigation into derivation of models and design of control strategies for powertrain and chassis control modules and integration into automotive platforms. Also presents software design, sensor selection, system architecture, diagnostics and reliability issues. Application is made to engine management, transmission and chassis systems with a consideration of vehicle performance, safety and information provision. *Preq:* M E 416 or equivalent.

AU E 828 Fundamentals of Vehicle Drivelines and Powertrain Integration 3(3,0) Study of vehicle powertrain arrangement, manual and automatic transmissions, automotive axles, four-wheel and two-wheel drives and design and manufacturing of gearing systems. Other topics, such as powertrain control to address dynamics in shifting, engine balancing and fuel economy, are addressed. Modeling and computer simulation are used extensively to analyze dynamic performance of various transmissions. *Preq:* M E 405, 416, or consent of instructor.

AU E 829 Tire Behavior and Its Influence on Vehicle Performance 3(3,0) In-depth analysis of the tire and its influence on vehicle performance including design, construction, structural response, rolling resistance, force and moment generation and behavior under dry/wet conditions. Tire models, their limitations and governing equations, tire characteristics on vehicle handling and safety and advanced control concepts in vehicle stability/braking are investigated. *Preq:* M E 453 or equivalent.

AU E 832 Vehicle Development and Integration Processes, Methods and Tools 3(3,0) Overview of the vehicle development process and the tools used in it, including voice of the customer, concept creation, packaging, product specification and target setting, including cost structures, lifecycle product management, prototype development and the role of the supplier. *Preq:* AU E 881.

AU E 833 Automotive Manufacturing Process Development, Methods and Tools 3(3,0) Overview of automotive manufacturing systems. Issues such as supplier integration, flexible manufacturing, aggregate planning, quality engineering and their applications to manufacturing systems are presented. Emphasizes opportunities and challenges presented with automotive manufacturing in a global environment, integrated processes, product development and automotive supply chain management.

AU E 834 Automotive Production Preparation, Management and Launch 3(3,0) Effective leadership and management of the product development and launch process. Includes responsibility and role definition, process management tools and software systems, detailed management of the supply chain, performance metrics and cost models and factors affecting launch success. Case studies of historic launch data and improvements are utilized.

AU E 835 Automotive Electronics Integration 3(3,0) Addresses the integration of electronic components and systems in automotive designs. Provides an overview of the major electronic systems in automobiles and describes how automotive manufacturers specify, integrate and evaluate these systems.

AU E 847 Vehicle Suspension Systems Design and Analysis 3(3,0) Study of concepts, theory, design and application of automotive suspension systems. Discusses suspension structure, configuration, geometry, kinematics, motion, static and dynamic load conditions as well as active, semi-active and passive systems. Suspension design factors and their effects are presented. Computer-aided engineering tools and other analytical techniques are demonstrated. *Preq:* M E 453 or equivalent.

AU E 848 Vehicle Braking Systems 3(3,0) Study of vehicle braking performance; development of system specifications; regulatory, customer and manufacturing requirements; brake balance and effects on stability and stopping distance; ABS systems; and computer simulation for system performance. *Preq:* M E 453 or equivalent.

AU E 849 Automotive Chassis Design 3(3,0) Integrative systems approach to the design and manufacture of automotive chassis and body components. Considers influence of design and manufacture on overall structural performance of the automobile, ride comfort, safety, durability, weight and cost. *Preq:* AU E 855 or equivalent, AU E 881.

AU E 850 Automotive Stability and Safety Systems 3(3,0) Discussion of passive/active systems and design philosophies. Investigates stability issues associated with vehicle performance and use of sensors and control system strategies for stability enhancement. Implementation and application to intelligent cruise control, lane departure warning systems, ABS, traction control, active steering systems and vehicle dynamic control systems are also discussed. *Preq:* M E 453 or equivalent.

AU E 853 Crash Analysis Methods and Crashworthiness 3(3,0) Consideration of crash legislation and testing; design constraints for crash; computational methods to analyze the mechanical response of automotive structure, systems and components to dynamic impact loading such as in crash situations; crush characteristics, structural collapse and their influence on safety; large-scale finite element analysis for large-scale deformation. *Preq:* AU E 852, 855, or consent of instructor.

AU E 855 Structural/Thermal Analysis Methods for Automotive Structure, Systems and Components 3(3,0) Methods to analyze the response of automotive structure, systems and components to static, dynamic and thermal loading. Includes coverage of critical loading conditions and system response objectives. Analysis methods focus on finite element approaches supplemented by simple computational methods when appropriate.

AU E 866 Advanced Materials for Automotive Applications 3(3,0) In-depth study of the broad range of engineering materials used in the construction of motor vehicles. Considers interrelations between materials microstructure, components manufacturing process and components service behavior. *Preq:* Consent of instructor.

AU E 867 Vehicle Manufacturing Processes I 3(3,0) In-depth analysis of main component and subsystem prototyping, fabrication assembly and integration processes used during production of automotive vehicles. Also discusses design for manufacturing, computer-aided manufacturing and rapid tooling technologies. *Preq:* Consent of instructor.

AU E 868 Vehicle Manufacturing Processes II 3(3,0) Continuation of AU E 867 with more emphasis placed on opportunities and challenges presented by automotive manufacturing in a global environment, integrated processes and product development and flexible and agile manufacturing. *Preq:* AU E 867.

AU E 875 Vehicle Development and Realization 3(3,0) In-depth analysis of component and subsystems design, representation, data management and analysis for vehicles. Voice of the customer, customer-driven design, product design specifications, life cycle product management, CAD/CAE representations, domestic and international standards, prototyping, design review and supplier relationships are considered using case studies.

AU E 876 Mass Customization Design for Vehicles 3(3,0) Consideration of concepts of platforms and product families, identification of common functionalities and the translation of functions into forms taking commonality into consideration. Also investigates designing product families and their role in vehicle design, the tie between market needs and appropriate manufacturing paradigm and specific applications to vehicle systems designs: chassis, wiring harnesses, engines.

AU E 877 Light-Weight Vehicle Systems Design 3(3,0) Methodological approaches to weight trade-off during design of vehicle systems, accounting for other functions, cost, safety, materials characteristics and manufacturing constraints. Includes topology optimization, multimaterial approaches and identification of the function optimal materials and material combinations using multi-objective formulations.

AU E 880 Vehicle Design/Manufacture Project Management 3(3,0) Development of management, leadership, sociocultural and technical skills training for the successful management of an automotive development or research team. Includes problem identification, team dynamics, decision making, ethics, strategy setting, project planning, scope management and implementation, target costing, marketing, design methods and design for X-concepts.

AU E 881 Automotive Systems: An Integrated Overview 3(3,0) Promotes understanding of the vehicle as a complex system and interactions of its subsystems in terms of performance. Topics include propulsion systems, suspensions and steering systems, tire-road interface, structural behavior and crashworthiness, materials and manufacturing, driver/occupants-vehicle interactions and onboard electronics. Modeling and simulation are used.

AU E 882 Systems Integration Concepts and Methods 3(3,0) Study of methods and tools to handle functional, geometric, production and IT integration. Includes instruction in managing performance trade-offs from the combination of systems designed for individual functions. Topics also include optimization methods, complexity, validation, signal and IT design and testing methods, robustness, architecture and quality.

AU E 883 Applied Systems Integration 3(2,3) Application of integration methods to practical and complex vehicle design and manufacturing systems. Includes prototyping, measurements, tolerancing and validation, as well as diagnosis and sensitivities, methods to diagnose sporadic software errors with hardware in the loop, design reviews, FMEA on function signal, geometry, production. Also includes Fault Tree analysis, innovation and change management, risk analysis and value analysis. *Preq:* M E 882, consent of instructor.

AU E 884 Styling Design 3(3,0) Considers fundamentals of styling design for the outer body and the interior cockpit. Utilizes concept sketching, drawing and prototyping, including virtual and physical, layered and clay based. Includes 2-D and 3-D representations, brand identifications, textures, materials, lighting, colors, and their use in automotive industrial design.

AU E 885 Vehicle Layout Engineering and Ergonomic Design 3(2,3) Study of vehicle layout specifications and considerations related to exterior and interior design. Ergonomics methods and tools as related to occupant accommodation and driver function are presented. Issues of assembly and manufacturing ergonomics are also covered. Case studies are utilized.

AU E 886 Vehicle Noise, Vibration and Harshness 3(3,0) Application of engineering tools and specifications for noise, vibrations and harshness. Sources, mitigation methods, complexity and influences on other vehicle functions are considered. Utilizes design, simulation and validation methods. *Preq:* M E 845 or equivalent.

AU E 887 Methods for Vehicle Testing 3(2,3) Investigates test planning for various performance regimes, data acquisition and analysis, uncertainty analysis, sensor selection, noise filtering, data reduction methods and track testing methods. Project includes actual vehicle tests.

AU E 890 Automotive Engineering Project 1-3(0,3-9) Industrial project work culminating in writing engineering reports. Projects cover comprehensive analytical and/or experimental treatment of phenomena of current interest in automotive engineering emphasizing modern technological problems. May be repeated for a maximum of nine credits.

AU E 892 Sustainable Vehicle Systems Seminar 1(1,0) Sustainable vehicle systems seminar. May be repeated for a maximum of 12 credits.

AU E 893 Selected Topics in Automotive Engineering 3(3,0) Advanced concepts in multibody systems dynamics including kinematics and kinetics of multibody systems, various methods for equation formulation and their limitations, numerical solutions methods, and applications to automotive systems and subsystems.

AU E 991 Doctoral Dissertation Research 1-12

BIOCHEMISTRY

BIOCH 606 Physiological Chemistry 3(3,0) Studies chemical basis of the mammalian physiological processes of muscle contraction, nerve function, respiration, kidney function and blood homeostasis. Discusses composition of specialized tissue such as muscle, nerve, blood and bone and regulation of water, electrolytes and acid-base balance. *Preq:* BIOCH 305 or Organic Chemistry.

BIOCH 623 Principles of Biochemistry 3(3,0) Study of the chemistry of amino acids, monosaccharides, fatty acids, purines, pyrimidines and associated compounds leads to an understanding of their properties and the relationship between structure and function that makes them important in biological processes. The use of modern techniques is stressed. *Preq:* CH 224 or equivalent.

BIOCH 631 Physical Approach to Biochemistry 3(3,0) Study of chemical and physical properties of amino acids, lipids, nucleic acids, sugars, and their biopolymers. Physical and mathematical analyses are correlated with biological structure and function. *Preq:* BIOCH 301 with a C or better or consent of instructor. *Creq:* Physical Chemistry.

BIOCH 632 Biochemistry of Metabolism 3(3,0) Study of central pathways of carbohydrate, lipid and nucleotide metabolism. Bioenergetics, limiting reactions, and the regulation and integration of the metabolic pathways are emphasized. *Preq:* BIOCH 301 and 431 with a C or better or consent of instructor.

BIOCH 633 General Biochemistry Laboratory I 2(0,4) Experiments selected to illustrate current methods used in biochemical research. *Creq:* BIOCH 431 or consent of instructor.

BIOCH 634 General Biochemistry Laboratory II 2(0,4) Continuation of BIOCH 433. *Preq:* Concurrent enrollment in BIOCH 432.

BIOCH 636 Molecular Biology: Genes to Proteins 3(3,0) Examines 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. *Preq:* BIOCH 301 and GEN 302 with a C or better, or consent of instructor.

BIOCH (GEN) 640 Bioinformatics 3(3,0) See GEN 640.

BIOCH 643 Molecular Basis of Disease 3(3,0) Topics in heritable human metabolic disorders including clinical features and newborn screening, genetic testing, the biochemical basis and treatment. *Preq:* BIOCH 301 or 305; and GEN 300 or 302 with a C or better; or consent of instructor.

BIOCH (GEN) 805 Issues in Research 3(3,0) Scientific writing, oral presentations and critical evaluation of them; legal and ethical issues associated with modern biochemical research. Science job hunting, time management and creativity for professional scientists are treated. *Preq:* Graduate enrollment in Biochemistry and Molecular Biology or consent of instructor.

BIOCH (GEN) 810 Principles of Molecular Biology 3(3,0) Introduction to the principles and techniques used to analyze prokaryotic and eukaryotic gene and genome structure, regulation of transcription initiation, regulation of protein synthesis and protein function. *Preq:* Enrollment in Genetics or Biochemistry and Molecular Biology or consent of instructor.

BIOCH 814 Advanced Biochemistry 3(3,0) Contemporary topics of functional and cellular aspects in biochemistry with particular focus on new observations, emerging ideas and important techniques. *Preq:* Two-semester sequence in biochemistry or consent of instructor.

BIOCH 815 Lipids and Biomembranes 3(3,0) Discusses isolation, chemical and physical properties, and metabolism of lipids; purification, structure, function and biosynthesis of biomembranes. *Preq:* BIOCH 632 or consent of instructor.

BIOCH 816 Signal Transduction 3(3,0) Characteristics and components of signal transduction processes in model species of plants, animals and microbes. *Preq:* BIOCH (GEN) 810 and GEN (BIOCH) 820, or consent of instructor.

BIOCH 818 Cellular Metabolism 3(3,0) Evolution, regulation, characterization and manipulation of metabolic pathways. *Preq:* BIOCH 814 and GEN (BIOCH) 820, or consent of instructor.

BIOCH (GEN) 820 Genomics and Proteomics 3(3,0) See GEN 820.

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

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

BIOCH (GEN) 825 Seminar I 1(1,0) See GEN 825.

BIOCH 828 Supramolecular Structure 3(3,0) Cellular structures such as viruses, ribosomes and various membrane systems, including rafts and some organelles, are described using modern methods of structural characterization. The methods and the theory of the methods are discussed along with the structures and their functions. *Preq:* BIOCH 814 or consent of instructor.

BIOCH 832 Structure and Function of Nucleic Acids 3(3,0) Physical, chemical and biochemical properties of nucleotides, oligonucleotides, RNA and DNA; antisense oligonucleotides and aptmers; unusual structures of RNA and DNA; nucleic acids-protein interactions; nucleic acids-metal interactions; small RNAs and RNA interference; catalytic nucleic acids; nucleic acids repair. *Preq:* BIOCH 814 or GEN 814 or consent of instructor.

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

BIOCH (GEN) 851 Seminar II 1(1,0) Investigation of current topics in biochemistry. May be repeated for a maximum of ten credits. To be taken Pass/Fail only.

BIOCH 890 Special Topics in Biochemistry 1-6(1,6,0) Group discussions of recent developments in biochemical research. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* BIOCH 814 or consent of instructor.

BIOCH 891 Master's Thesis Research 1-12

BIOCH 991 Doctoral Dissertation Research 1-12

BIOENGINEERING

BIO E 612 Orthopaedic Engineering and Pathology 3(3,0) Interdisciplinary study of clinical orthopaedic cases (bone growth, bone remodeling, osteoarthritis, implant fixation and joint replacements); biomechanical, biomaterials, tribology and clinical diagnosis of failed implants (total joint replacements, fracture fixation and spinal instrumentation); basic concepts of orthopaedic pathology for engineers. *Preq:* BIO E 302, 320, BIOSC 315.

BIO E 615 Research Principles and Concepts 1(1,0)

Introduces seniors and graduate students to 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. To be taken Pass/Fail only.

BIO E 623 Cardiovascular Engineering and Pathology 3(3,0) Medical and bioengineering aspects of artificial cardiovascular and vascular devices; physiology and pathological aspects of patients with need for such devices; diagnostic techniques and surgical management of diseases and pathology; design aspects of current devices and selection; state of the art in experiments and human clinical trials. *Preq:* BIO E 302, 320, 370, BIOSC 315.

BIO E 631 Medical Imaging 3(3,0) Introduction to the history, physics, and basis of medical imaging devices, including X-ray, Computed Tomography, Magnetic Resonance Imaging, and Ultrasound. Students understand imaging from both an engineering and clinical prospective. Students have the opportunity to work with real medical images to understand the trade-offs between modalities. *Preq:* BIO E 370 or equivalent or consent of instructor.

BIO E 635 Computer Modeling Multiphysics Problems 3(3,0) Introduces students to a holistic way to deal with complicated engineering problems using a computer modeling approach. For example, a real-world problem governed by combined mechanical, electrical, thermal, electrochemical and mass-transport phenomena is dealt with in an integrated and multidisciplinary way rather than the conventional piece-wise, single-discipline way. *Preq:* MTHSC 208.

BIO E 640 Biotechnology for Bioengineers 3(3,0) Explores the principles necessary to use microorganisms, tissue culture and enzymes in bioengineering applications, including molecular techniques, fermentation, process scale-up, purification processes and FDA regulations. Emphasizes production of biopharmaceuticals derived from recombinant systems, including uses in medical systems. *Preq:* BIOCH 305 or consent of instructor.

BIO E 671 Biophotonics 3(3,0) Biophotonics is an interdisciplinary subject of applying photonics to study biological samples from individual cells to the entire body. Course introduces fundamental and frontier topics in optical imaging aspects of biophotonics for senior-level undergraduates and graduate students to gain the ability to solve bioimaging-related biomedical problems. *Preq:* MTHSC 208; PHYS 221; E C E 320; or consent of instructor.

BIO E 682 Biomaterial Implantology 3(2,3) Provides training in the planning and conduct of experimental surgery, including laws and regulations; institutional requirements; selection of animal models; ethical considerations of animal research; preparation of animals for surgery; general and special surgical techniques; aseptic surgical techniques; and basic and applied instrumentation. *Preq:* Junior standing in Bioengineering.

BIO E 800 Seminar in Bioengineering Research 1(2,0) Original research in bioengineering; weekly one-hour seminar associated with weekly recitation covering seminar preparation, presentation, professional writing, bioengineering ethics and related topics. To be taken Pass/Fail only.

BIO E 801 Biomaterials 3(3,0) 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. *Preq:* Consent of instructor.

BIO E 802 Compatibility of Biomaterials 3(1,6) 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(3,0) 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. *Preq:* Consent of instructor.

BIO E 807 Nanotechnology and Biomaterials 3(3,0) The emerging field of nanotechnology and its relation to solving bioengineering and health-related problems is treated. Also considers the promise of nanotechnology in the creation and utilization of materials and devices at the level of atoms and molecules. New scientific approaches, research tools, clinical tools, and devices are presented.

BIO E 811 Sterilization and Cleaning Engineering for Medical Devices 3(2,3) Detailed overview of sterilization, cleaning, and packaging requirements for reprocessing medical devices. Emphasizes evaluation methods for materials analysis, biocompatibility, and sterilization/cleaning methods in manufacturing and healthcare sectors. Compliance with industry and government regulations is addressed, including packaging processes, container types, and equipment design and processing for sterilization and cleaning. *Preq:* BIO E 801, or consent of instructor.

BIO E 813 Industrial Bioengineering 3(3,0) A broad-based understanding of industry-related functions and knowledge base to allow students to quickly adapt to industrial careers in medical device research and development and to understand the additional roles and interplay between quality, sales, product development methodology, and regulations. *Preq:* Consent of instructor; graduate standing in bioengineering.

BIO E 814 Medical Device Commercialization 3(3,0) Overview of design control and regulations for medical device reprocessing and their practical application in the scope of project management and commercialization. Introduction to a cross disciplinary approach for launching and marketing a new device, including device lifecycle management and intellectual property laws relative to the medical device reprocessing industry. *Preq:* Consent of instructor.

BIO E 815 Design, Manufacturing and Validation Methods for Reusable Medical Devices 3(3,0) Overview of design theories, methods and best practices governing the medical device reprocessing industry. Materials, fabrication processes and manufacturing techniques with an emphasis on remanufacturing, reprocessing and sustainability. Students gain the knowledge and skills needed to comply with process verification and validation requirements for Quality System Regulations with emphasis on a reprocessing approach. *Preq:* BIO E 811 or consent of instructor.

BIO E 820 Structural Biomechanics 3(3,0) 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. *Preq:* Consent of instructor.

BIO E 824 Cellular and Molecular Analysis in Tissue Engineering 4(3,3) Describes the molecular basis for cell regulation by extracellular stimuli including growth factors, matrix and force. Also describes theoretical and laboratory instruction in research methods used to analyze cellular signaling and functional response in the design and evaluation of tissue engineering constructs. *Preq:* BIO E 849 or consent of instructor.

BIO E 825 Cardiac Pathophysiology and Pharmacology 3(3,0) Advanced structural and functional aspects of the cardiovascular system, including cardiac physiology and cellular electromechanical physiology, pathological processes and congenital defects of the cardiovascular system as depicted in an invasive cardiovascular laboratory. Standard cardiovascular pharmacologic agents are discussed as they relate to the electrophysiology patient. *Preq:* BIO E 370, BIOSC 315, or equivalent, and consent of instructor.

BIO E 826 Cardiac Electrophysiology Laboratory 3(0,9) Introduction to procedure room preparation, aseptic technique, regulatory compliance, patient identification and procedural consent; medical record and laboratory results review; and appropriate conduct with patients and staff. Instruction on identification and use of standard surgical instruments, cardiac catheter placement and potential complications. Calibration and assessment of intracardiac and intra-arterial pressure waveforms. *Coreq:* BIO E 825 or consent of instructor.

BIO E 827 Cardiac Electrophysiology and Arrhythmias 3(3,0) Recording and interpreting electrocardiograms (ECG). Identification and measurement of ECG waveforms, parameters, recording errors and artifacts. Use of standard ECGs, Holter and Event monitors, implantable loop recorders, stress tests, signal averaged, ECGs, T-wave alternans testing. Mechanisms of arrhythmia formation and methods of pharmacologic and interventional treatments. *Coreq:* BIO E 826 or consent of instructor.

BIO E 828 Implantable Cardiac Devices 3(1,6) Design of clinically used pacemakers, defibrillators, and cardiac resynchronization devices. Covers modes and basic timing cycles of pacemakers; testing of leads for sensing, impedances, and capture thresholds; pacemaker malfunction assessment; programming of antitachycardia pacing and defibrillation threshold testing for defibrillators; and device surgical implantation and explanation and methods of lead extraction. *Preq:* BIO E 826 or consent of instructor.

BIO E 829 Interventional Electrophysiology Procedures 3(1,6) Interventional electrophysiology procedures, including baseline interval measurements, pulse stimulator control for diagnostic information, conduction system and refractory periods assessment. Supraventricular and ventricular tachyarrhythmias assessment, post-pacing and pacing protocols; radiofrequency ablation and complications; radiofrequency generator and irrigated tip ablation systems and transseptal punctures. *Preq:* BIO E 826 and 827 or consent of instructor.

BIO E 830 Interventional Electrophysiology Imaging 2(0,6) Methods of imaging utilized during electrophysiologic procedures. Three-dimensional CT images of the heart editing; echocardiographic planer images for three-dimensional cardiac chambers; standard radiographic imaging techniques, including rotational angiography; 3-D electro-anatomic maps for arrhythmia assessment and ablative treatment. *Coreq:* BIO E 829 or consent of instructor.

BIO E 831 Advanced Electrophysiology Procedures 2(0,6) Electrophysiologic procedures and methods to treat atrial fibrillation and ventricular tachycardia; recording, imaging, mapping and ablative methods; and setup and maintenance of robotic mapping and ablation. *Preq:* BIO E 828 and 829 or consent of instructor.

BIO E 832 Advanced Electrophysiology Problem Solving 2(0,6) Trouble shooting of electrical noise, grounding problems, fractured cables, insulation breaks, computer and imaging errors. Covers treatment of complications from procedures such as respiratory failure, cardiac tamponade, cardiac arrest, stroke, loss of pacing capture, use of transcutaneous pacing, external defibrillation, inappropriate shocks, placement of pericardial drains, chest tubes, and hematoma expansion. *Coreq:* BIO E 831 or consent of instructor.

BIO E 846 Biomedical Basis for Engineered Replacement 3(3,0) Form and function of human organs, major systems and examples of engineering repair and replacement methods are presented in light of pathological or traumatic organ malfunction. Core course for all Bioengineering graduate students, taken preferably during their first fall semester.

BIO E 847 Transport Processes in Bioengineering 4(4,0) Mathematical modeling of blood flow through capillaries and solute transfer from capillaries to tissues by diffusion and convection, pharmacokinetic analysis of drug adsorption, transport and elimination routes in body, and analysis of the design and performance of extracorporeal devices for organ replacement, including hemodialysis, blood oxygenation and immobilized enzyme reactors. *Preq:* MTHSC 208 or equivalent.

BIO E 848 Cellular Interactions with Biomaterials 4(2,2) 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 physio-chemical properties which influence cellular interactions; interactions between implant materials and host tissues at the cellular and molecular level; overview of tissue engineering.

BIO E 849 Tissue Engineering 3(3,0) Principles and practices of bioartificial organ and tissue development; cellular/material interaction and translation of information from two-dimensional surfaces to three-dimensional scaffolds; selection and processing of biomaterials to form tissue scaffolds; analysis of tissue engineered devices, standards and regulation. *Preq:* BIO E 801, 846.

BIO E 850 Selected Topics in Biomedical Engineering 1-4(0,4,12-0) Advanced topics in bioengineering intended to develop in-depth areas of particular student interest. Credit may be earned for more than one semester. *Preq:* Consent of instructor.

BIO E 870 Bioinstrumentation 3(2,2) 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(2,6) 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. *Preq:* BIOSC 459 or equivalent.

BIO E 890 Internship 1-5 Observation and assignment in a medical college, dental college, hospital, veterinary clinic, dental clinic, health service, or industrial department. *Preq:* Consent of department chair.

BIO E 891 Master's Thesis Research 1-12

BIO E 892 Nonthesis Independent Study in Bioengineering 1-6 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. To be taken Pass/Fail only.

BIO E 991 Doctoral Dissertation Research 1-12

BIOLOGICAL SCIENCES

BIOSC (ENT) 600 Insect Morphology 4(3,3) See ENT 600.

BIOSC 601 Plant Physiology 3(3,0) 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. *Preq:* BIOL 104/106 or 111 or BIOSC 205 and CH 102. *Coreq:* BIOSC 602.

BIOSC 602 Plant Physiology Laboratory 1(0,3) 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. *Coreq:* BIOSC 601.

BIOSC (GEN) 605 Molecular Genetics of Eukaryotes 3(3,0) See GEN 605.

BIOSC 606 Introductory Plant Taxonomy 3(3,0) Introduction to the basic principles and concepts of plant systematics with emphasis on the plants of South Carolina. *Preq:* BIOL 104/106 or 111 or BIOSC 205. *Coreq:* BIOSC 607.

BIOSC 607 Plant Taxonomy Laboratory 1(0,3) Introduction to the basic techniques of plant taxonomy with laboratory and field emphasis on the flora of South Carolina. *Coreq:* BIOSC 606.

BIOSC 608 Comparative Vertebrate Morphology 3(3,0) Phylogeny and diversity of vertebrates and study of their comparative morphology, leading to an understanding of the relationships and functioning of living organisms. *Preq:* BIOL 104 or 111. *Coreq:* BIOSC 609.

BIOSC 609 Comparative Vertebrate Morphology Laboratory 2(0,5) Comparative anatomy of representative vertebrates; methods used in preparing specimens for study and display. *Coreq:* BIOSC 608.

BIOSC 610 Limnology 3(3,0) Detailed introduction to the 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. *Preq:* Junior standing in a life science or consent of instructor.

BIOSC 611 Limnological Analyses 2(1,2) Examines a 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 provides rationale and methods for quantitative analyses of biota, as well as some integrated analyses of whole ecosystems. *Preq or Coreq:* BIOSC 610 or 643.

BIOSC (E N R) 613 Restoration Ecology 3(3,0) See E N R 613.

BIOSC (AVS, MICRO) 614 Basic Immunology 3(3,0) See MICRO 614.

BIOSC (ENT) 615 Insect Taxonomy 3(1,6) See ENT 615.

BIOSC 617 Marine Biology 3(3,0) Survey of organisms that live in the sea and their adaptations to the marine environment. Emphasizes characteristics of marine habitats, organisms and the ecosystems. *Preq:* BIOL 104/106, 111, or consent of instructor.

BIOSC 620 Neurobiology 3(3,0) Broad background in neurobiology. Topics include 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. *Preq:* BIOCH 301 or 305 or consent of instructor.

BIOSC (PL PA) 625 Introductory Mycology 3(3,0) Introduction to the biology of all the groups of fungi and some related organisms, with considerations of the taxonomy, morphology, development, physiology and ecology of representative forms. *Preq:* BIOL 104/106 or 111 or BIOSC 205. *Coreq:* BIOSC (PL PA) 626.

BIOSC (PL PA) 626 Mycology Practicum 2(1,3) Application of the principles of mycological techniques, including isolation, culture, identification and microscopic study of fungi. Includes examples from all major groups of fungi. *Coreq:* BIOSC (PL PA) 625.

BIOSC 628 Quantitative Biology 4(3,3) Applies quantitative methods to a wide range of biological problems. Main focus is on building modeling skills using population, physiological, genetic and evolutionary problems. Also includes a review of statistical principles and introduces basic bioinformatics techniques. *Preq:* BIOL 104, 111, or equivalent; MTHSC 108 or equivalent.

BIOSC 632 Animal Histology 3(3,0) 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. *Preq:* BIOSC 303 or consent of instructor. *Coreq:* BIOSC 633.

BIOSC 633 Animal Histology Laboratory 2(1,2) Microscopic examination of basic animal tissue types and the tissue makeup of organs which comprise systems. *Coreq:* BIOSC 632.

BIOSC (ENT) 636 Insect Behavior 3(2,3) See ENT 636.

BIOSC 640 Developmental Animal Biology 3(3,0) 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 are analyzed in terms of fundamental concepts and control processes. *Preq:* BIOCH 301 or 305 or consent of instructor. *Coreq:* BIOSC 650.

BIOSC 641 Ecology 3(3,0) Study of basic ecological principles underlying the relationships between organisms and their biotic and abiotic environments. Includes physiological, population and community ecology, with applications of each to human ecological concerns. *Preq:* BIOL 104/106, 111, BIOSC 205, or consent of instructor.

BIOSC 642 Biogeography 3(3,0) Study of patterns of distribution of plants and animals in space and time. *Preq:* BIOSC 302 or 303 and 304 or 305 or consent of instructor.

BIOSC 643 Freshwater Ecology 3(3,0) Study of basic ecological principles and concepts as they apply to freshwater environments: rivers and streams, wetlands, lakes and ponds and reservoirs. *Preq:* Junior standing in a life science or consent of instructor.

BIOSC 644 Freshwater Ecology Laboratory 2(1,2) Laboratory-based course providing a synthesis of major components of freshwater ecosystems. Activities are hypothesis driven and relate to each other to form an overall synthesis of the field. Hands-on experience allows engagement in creative inquiry. *Preq or Coreq:* BIOSC 443 or equivalent or consent of instructor.

BIOSC 645 Ecology Laboratory 2(1,2) Modern and classical approaches to the study of ecological problems discussed in BIOSC 441. Students are introduced to field, laboratory and computer-based analyses of plant and animal populations and communities. *Preq or Coreq:* BIOSC 641.

BIOSC 646 Plant Ecology 3(3,0) Ecology of plants in relation to their biotic and abiotic environments. Individual organisms, populations and communities are considered with an emphasis on seed plants in terrestrial environments. *Preq:* BIOL 104/106, 111, or BIOSC 205, or consent of instructor.

BIOSC 647 Plant Ecology Laboratory 2(1,2) Experimental and observational approach to addressing principles discussed in BIOSC 646. Students are introduced to field and laboratory methods involving individual organisms, populations and communities. *Preq or Coreq:* BIOSC 646 or consent of instructor.

BIOSC 650 Developmental Biology Laboratory 2(1,2) Examines a broad range of topics concerned with the development of multicellular 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. *Preq or Coreq:* BIOSC 640 or equivalent.

BIOSC (PL PA) 654 Plant Virology 4(3,3) Study of 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. Control of plant viral diseases. *Preq:* BIOCH 301, MICRO 305, or consent of instructor.

BIOSC (MICRO) 656 Medical and Veterinary Parasitology 3(3,0) Introduction to parasitism in the animal kingdom; emphasizes basic and applied principles related to economically and medically important diseases. Classical and experimental approaches to the study of parasitism are examined in reference to protozoa, helminths and arthropods. *Preq:* BIOL 104/106 or 111. *Coreq:* BIOSC 657.

BIOSC (MICRO) 657 Medical and Veterinary Parasitology Laboratory 2(1,2) Laboratory to reinforce material presented in BIOSC 656. Introduces students to both live and preserved human/animal parasites. Also introduces techniques used in collection, preservation and examination of animal parasites. *Coreq:* BIOSC 656.

BIOSC 658 Cell Physiology 3(3,0) Study of the chemical and physical principles of cell function emphasizing bioenergetics and membrane phenomena. *Preq:* BIOCH 301 or 305 or consent of instructor.

BIOSC 659 Systems Physiology 3(3,0) 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. *Preq:* One year each of biology, chemistry and physics or consent of instructor.

BIOSC 660 Systems Physiology Laboratory 2(1,2) Modern and classical experimental methods are used to demonstrate fundamental physiological principles discussed in BIOSC 659. Students are introduced to computer-aided data acquisition and computer simulations of physiological function. *Preq or Coreq:* BIOSC 659.

BIOSC 661 Cell Biology 3(3,0) 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. *Preq:* BIOCH 301 or consent of instructor.

BIOSC 662 Cell Biology Laboratory 2(1,2) Accompanies BIOSC 661; focuses on molecular and microscopic analysis of eukaryotic cells. *Coreq:* BIOSC 661.

BIOSC 664 Mammalogy 4(3,3) Origin, evolution, distribution, structure and function of mammals with laboratory emphasis on mammals of the Southeast. Field trips and live trapping of mammals are required. *Preq:* BIOSC 303 or consent of instructor.

BIOSC 666 Evolution of Human Behavior 3(3,0)

Familiarizes students with the evolutionary basis of human behavior. Examines topics such as altruism, cooperation, mating systems, parental investment and social systems using diverse examples, from hunter-gatherer to technological societies. *Preq:* ANTH 351, BIOSC 335, 470, or PSYCH 201; or consent of instructor.

BIOSC (W F B) 668 Herpetology 4(3,3)

BIOSC 825 Comparative and Veterinary Immunology 3(3,0) Survey of the evolutionary relationships, the physiology and the cellular/molecular biology of the immune systems of animals; demonstrations that focus on those animals having high economic input, biomedical importance, or a key ecological position; current research with a historical perspective. *Preq:* AVS 825, MICRO 614, or consent of instructor.

BIOSC 826 Epigenetics in Eukaryotes 3(3,0) Focuses on epigenetics in eukaryotes and discusses how epigenetic changes modulate gene expression and post-translational modification. Topics include specific decorations of the DNA, the proteins that help compact DNA, and the importance of chromatin structure in maintaining characteristics of cell or organism, such as immortalization or aging. *Preq:* MICRO 417, H417 or 617, or consent of instructor.

BIOSC (ENTOX) 830 Mechanistic Toxicology 3(3,0) See ENTOX 830.

BIOSC (ENTOX) 831 Biomarkers in Toxicology 3(1,6) See ENTOX 831.

BIOSC 840 Understanding Biological Inquiry 3(3,0) Online course for teachers and others who want to apply inquiry methods to biological problems. Provides a broad background into the scientific methods utilized in the biological sciences and the application of inquiry-based teaching methods in the classroom.

BIOSC 841 Understanding Ecology and Ecosystems 3(3,0) Online course for teachers and others who want to understand ecological interactions and systems. Provides a broad background in ecology that includes populations, habitats, communities, trophic interactions and ecosystems; and provides a foundation for understanding interactions between organisms and their environments.

BIOSC 842 Understanding Cellular Processes 3(3,0) In-depth analysis of essential cell biology topics. Students study how and where intracellular and extracellular molecules control cellular functions such as gene expression, secretion, motility, signaling, cell-cycle control and differentiation.

BIOSC 843 Understanding Genetics and Evolutionary Biology 3(3,0) Online course for teachers who want to increase their content knowledge in genetics and evolution. Topics include Mendelian genetics, molecular genetics, gene expression and regulation, population genetics, forces of evolutionary change, and the role of evolutionary change in the origin of new species.

BIOSC 844 Understanding the Human Body 3(3,0) Online course for teachers and others who want to increase their content knowledge about the anatomy and physiology of the 11 organ systems in the human body. Studies include food processing and nutrient allocation, circulation and respiration, excretion, communication via hormones and nervous transmission, reproduction, behavior, locomotion and support. *Preq:* Consent of instructor.

BIOSC 845 Understanding Vertebrate Biology 3(3,0) Online course for teachers and others who want to increase their content knowledge about the taxonomy, morphology, adaptations and evolution of vertebrates. *Preq:* Consent of instructor.

BIOSC 846 Understanding Plant Biology 3(3,0) Online course for teachers and others who want to increase their content knowledge about plants. Study of plants from bryophytes to angiosperms, including growth, photosynthesis, nutrition, reproduction, ecology and evolution. *Preq:* Consent of instructor.

BIOSC 847 Understanding Microbiology 3(3,0) Online course for teachers and others who want to increase their knowledge of microorganisms. Topics include prokaryotic cell structure and function, microbial growth and growth control, food microbiology, bacterial genetics, immunology, virology, microbial diseases, and epidemiology. Laboratory concepts are emphasized.

BIOSC 848 Understanding Scientific Research 3(3,0) Examines research problems in selected areas of biological sciences as an introduction to research planning and techniques. Teachers undertake an instructor-approved, individual research project or a group research project involving their classroom during the academic year. Both are assisted by and under the supervision of the instructor.

BIOSC 849 Understanding Scientific Communication 3(3,0) Online course to help teachers develop their ability to write grant proposals, scientific manuscripts, and conference presentations on biological topics, and to communicate about biological issues with public audiences.

BIOSC (ENTOX) 854 Aquatic Toxicology 3(3,0) See ENTOX 854.

BIOSC 863 Special Problems 1-4 Research not related to thesis. *Preq:* Consent of instructor.

BIOSC 871 Selected Topics 1-4(1-4,0) Cellular and developmental biology, ecology, behavior, evolutionary biology, molecular biology, physiology, systematics and other topics of interest to graduate students in the biological sciences. May be repeated for credit, but only if different topics are covered. *Preq:* Consent of instructor.

BIOSC 872 Selected Topics Laboratory 1-4(0,2-8) 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. *Preq:* Consent of instructor.

BIOSC 888 Electron and Light Microscopy Practicum 3(1,5) Continuation of BIOSC 687, offering graduate students practical training on light and electron microscopes. Proficient students become approved end users by performing approved, independent imaging projects. *Preq:* BIOSC 687 and consent of instructor.

BIOSC 891 Master's Thesis Research 1-12

BIOSC 991 Doctoral Dissertation Research 1-12

BIOMOLECULAR ENGINEERING

BMOLE 603 Biotransport Phenomena 3(3,0)

Analysis of single and multidimensional steady-state and transient problems in momentum, mass and energy transfer in biological systems. Mathematical similarities and differences in these mechanisms are stressed and mathematical descriptions of physiological and engineering systems are formulated. *Preq:* CH E 330, MTHSC 208.

BMOLE 623 Bioseparations 3(3,0) Study of principal methods of separation and purification of bioproducts, such as proteins, amino acids and pharmaceuticals. Topics include analytical bioseparations, membrane separations, sedimentation, cell disruption, extraction, adsorption, chromatography, precipitation, crystallization and drying. *Preq:* BIOCH 301, 305, or 423; CH E 330; or consent of instructor.

BMOLE 625 Biomolecular Engineering 3(3,0) Introduction to basic principles of biomolecular engineering: the purposeful manipulation of biological molecules and processes applied to problems and issues in the life sciences, biotechnology and medicine. Topics include carbohydrates, proteins, nucleic acids and lipids with emphasis on their structure-property-function relations; molecular recognition; biochemical pathway engineering; and cell growth. *Preq:* CH E 230 and 319 or consent of instructor.

BMOLE 626 Biosensors and Bioelectronic Devices 3(3,0) Development of methodologies used to design, fabricate and apply biosensors and bioelectronic devices for the environmental, medical and chemicals industries. Application of the fundamentals of measurement science to optical, electrochemical, mass and thermal means of signal transduction. Use of the fundamentals of surface science to interpret bio-immobilization and biomolecule-surface interactions. *Preq:* CH E 330, and BIOCH 301 or 305, or consent of instructor.

BMOLE 627 Membranes for Biotechnology and Biomedicine 3(3,0) Students learn principles of membrane science and technology and study membrane applications in the biotechnology and biomedical industries. Advanced topics include surface modification of membranes, synthesis of porous membranes for biomedical applications such as tissue engineering, environmentally responsive membranes and membrane-based biomedical devices. *Preq:* CH E 330 or equivalent or consent of instructor.

BMOLE 810 Biosensors and Bioelectronic Devices 3(3,0) Study of methodologies in design, fabrication and application of biosensors and bioelectronic devices for monitoring the environmental, medical and chemical industries. Includes measurement science fundamentals applied to optical, electrochemical, mass and thermal means of signal transduction. Also considers surface science fundamentals to interpret bioimmobilization, biofouling and nonspecific interactions of enzymes, antibodies and DNA at surfaces. *Preq:* Consent of instructor.

BIOSYSTEMS ENGINEERING

B E (CSENV) 608 Land Treatment of Wastewater and Sludges 3(3,0) See CSENV 608.

B E 610 Biological Kinetics and Reactor Modeling 3(2,3) Fundamentals of microbial and biochemical kinetics used in analysis and design of biological systems. Topics include mathematical and computer modeling of biological kinetics and systems, estimating model coefficients, and development of microbial kinetic models as basis for batch and continuous reactor design. *Preq:* B E 212, MTHSC 208 or consent of instructor.

B E 612 Heat and Mass Transport in Biosystems Engineering 3(3,0) Fundamentals of heat and mass transport used in engineering design and analysis of biological systems; principles of steady state and transient energy and mass balances including chemical and biological generation terms. *Preq:* B E 410, MTHSC 208. *Coreq:* M E 310 or consent of instructor.

B E 614 Biosystems Engineering Unit Operation 3(2,3) Applies the basic principles of statics, dynamics and thermodynamics to design of mechanical and electrical systems supporting biological operations and processes. *Preq:* B E 314, M E 310.

B E 615 Instrumentation and Control for Biosystems Engineers 4(3,3) Overview of modern instrumentation techniques and digital electronic components and subsystems to integrate them into digital data acquisition and control systems for biosystems. Emphasizes laboratory use of equipment. Topics include characteristics of instruments, signal conditioning, transducer theory and applications, programmable logic controllers, and digital data acquisition and control. *Preq:* E C E 307.

B E 617 Applied Instrumentation and Control for Biosystems 2(1,3) Study of hardware and software implementation of digital data acquisition and control systems for application to agriculture, aquaculture, biotechnology and other biosystems. Topics include digital electronic circuits and components, microcomputer architecture, interfacing and programming. *Preq:* B E 415 or consent of instructor.

B E 622 Hydrologic Modeling of Small Watersheds 3(3,0) Design of structures and development of best management practices for runoff, flood and sediment control from rural and urban areas, including natural and disturbed watersheds. Topics include modeling of prismatic and non-prismatic channels, culverts and detention/retention ponds. *Preq:* B E 322 or consent of instructor.

B E 628 Biochemical Engineering 3(3,0) Use of microorganisms and enzymes for the production of chemical feedstocks, single-cell protein, antibiotics and other fermentation products. Topics include kinetics and energetics of microbial metabolism, design and analysis of reactors for microbial growth and enzyme-catalyzed reactions, and considerations of scale-up, mass transfer and sterilization during reactor design. *Preq:* B E 410 or CH E 330 or consent of instructor.

B E 635 Applications in Biotechnology Engineering 3(2,3) Bioengineering principles applied to the expanding fields of agricultural biotechnology, ecotechnology and biomedical technology. Special applications include waste treatment and ecological engineering, bioreactor propagation of plant and animal cells and tissues, applied genomics and synthetic seed production, biosensors and biomonitoring, biological implants and materials biocompatibility. *Preq:* B E (CH E) 428.

B E 638 Bioprocess Engineering Design 3(2,2) Design and analysis of systems for processing biological materials. Topics include biotechnology, thermodynamics, transport processes and biological properties related to bioprocess design and computational simulation. Unit operations include basic bioreactor operation, bioseparations, and preservation techniques. *Preq:* B E 428.

B E 640 Renewable Energy Resource Engineering 3(2,2) Investigation into merging renewable energy resources, including detailed study of solar, wind and bioenergy alternatives. Also includes principles, technologies and performance evaluation of components for these technologies and an introduction to tidal, hydro, geothermal and other energy; energy conservation; cogeneration; financial, economical and other issues related to alternative energy sources. *Preq:* Science or engineering major, consent of instructor.

B E (EE&S, FOR) 651 Newman Seminar and Lecture Series in Natural Resources Engineering 1(0,2) Topics dealing with development and protection of land, air, water and related resources are covered by seminar with instructor and invited lecturers. Current environmental and/or resource conservation issues are addressed. *Preq:* Senior standing, consent of instructor.

B E 664 Non-Point Source Management in Engineered Ecosystems 3(2,3) Fundamentals of non-point source pollution including quantification of environmental impact and ecosystem management related to contaminants and nutrients and to planning and design of ecological systems. *Preq:* MICRO 305, senior standing in engineering, or consent of instructor.

B E (EE&S) 684 Municipal Solid Waste Management 3(3,0) See EE&S 684.

B E 781 Special Problems 1-3(1-3,0) Students select subjects and conduct library, laboratory and/or field research. A technical report documenting the study is required. May be repeated for a maximum of six credits. *Preq:* Master's degree candidate in Engineering.

B E 822 Principles and Practice of Stream Restoration 3(2,3) Introduction to hydraulic and sediment transport processes associated with stream restoration practice. Emphasis is on learning to research, document and present a rationale for a recommended alternative to a degraded stream. Research centers around a degraded stream system. *Preq:* B E 622 or consent of instructor.

B E 835 Industrial Biotechnology Techniques 4(3,3) Introduces industrial biotechnology techniques with emphasis on bioproduction, pilot bioprocessing equipment operation, biopharmaceutical storage, process simulation and economics, project management, good laboratory practice (GLP), and current good manufacturing practice (cGMP) geared toward the biotechnology industry. *Preq:* B E 638 or BIOCH 633, GEN (BIOSC) 616, or consent of instructor.

B E 838 Advanced Bioprocess Engineering 3(3,0) Advanced bioprocessing techniques with emphasis on processing and modeling aspects of eukaryotic systems and associated bioproducts. Modules include thermal processing, supercritical fluid extraction, and advanced biological thermodynamics, chromatography and spectroscopy. *Preq:* B E 438/638 or consent of instructor.

B E 865 Advanced Biological Transport Processes 3(3,0) Study of transient transport processes in biological materials and systems. Incorporates mathematics describing active and passive cellular transport. Emphasizes numerical solution techniques for coupled transport relationships in non-ideal, heterogeneous systems, including biological kinetic and thermodynamic considerations. *Preq:* BIOCH 305, CH E 601, MTHSC 634, or consent of instructor.

B E 871 Selected Topics in Biosystems Engineering 1-3(1-3,0) Supervised, in-depth study of an area related to biosystems engineering not covered in other courses. May be repeated for a maximum of six credits.

B E 891 Master's Thesis Research 1-12

B E 901 Special Problems in Agricultural Engineering 3(3,0) 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. A technical report is required.

B E 991 Doctoral Dissertation Research 1-12

BOTANY

BOT 821 Inorganic Plant Metabolism 3(3,0) Study of plant, soil, water and nutrient relations. Topics include permeability, uptake and translocation, transpiration and mineral nutrition. Offered fall semester of odd-numbered years only. *Preq:* BIOSC 601 and 602 or consent of instructor.

BOT 822 Organic Plant Metabolism 3(3,0) Discusses respiration and photosynthesis; synthesis, translocation, storage, transformation and degradation of organic materials, fats, carbohydrates, proteins, pigments and nucleic acids. Offered spring semester of even-numbered years only. *Preq:* BIOSC 601 and 602 and BIOCH 623 or consent of instructor.

BOT (CSENV) 824 Mode of Action of Growth Substances 4(3,3) See CSENV 824.

BOT 831 Advanced Plant Taxonomy 4(3,3) Study of the principles of plant classification including relationships and characteristics of major groups of vascular plants. Students collect and identify spring flora of the area. Offered spring semester of odd-numbered years only. *Preq:* BIOSC 606 or consent of instructor.

BOT 850 Plant Tissue and Cell Culture 3(2,3) Methods and principles of plant tissue and cell culture: cloning, embryogenesis, protoplast fusion, plant regeneration, potential of plant genetic engineering. Offered fall semester of odd-numbered years only. *Preq:* Introductory plant physiology or consent of instructor.

BOT 860 Plant Anatomy and Cell Biology 4(3,3) Covers the subcellular structure and the comparative organization and function of plant cell-types, tissues and organs. Emphasizes the interplay between the environment and the plant body and among genomes, membrane compartments and the cytoplasm as these relate to the highly orchestrated stages in development. Offered spring semester of even-numbered years only.

BUSINESS ADMINISTRATION

M B A 803 Statistical Analysis of Business Operations 3(3,0) 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. Special attention is given to efficient and relevant data collection and interpretation.

M B A 805 Enterprise, Government and the Public 3(3,0) 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.

M B A 806 Operations Management 3(3,0) 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. *Prreq:* M B A 818 and 830, or equivalent, or consent of instructor.

M B A 807 Financial Management 3(3,0) Theory of financial management as it relates to the financial problems faced by business concerns. Concepts developed are used to assess the validity of emerging formalized techniques for improving decision making in the financial area. Topics include financial planning, short- and long-term fund raising, capital budgeting, the administration of working capital, recapitalization, listing of securities and reorganization. Case material and problems are used. *Prreq:* M B A 804 or 854 or equivalent, and M B A 803 or 853 or equivalent.

M B A (MGT) 809 Organizational Behavior and Human Resources Management 3(3,0) 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 resources strategy, selection, performance evaluation, reward systems and employee development.

M B A 811 International Business Management 3(3,0) Survey and analysis of managerial theory and the practice of international business, including the influence of cultural, economic, political and financial factors affecting the management of the firm. Case studies of companies engaged in international business are discussed.

M B A 812 Financial Markets and Institutions 3(3,0) 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. *Prreq:* M B A 807 or consent of instructor.

M B A 814 Directed Research in Quantitative Analysis 3(3,0)

M B A 815 Directed Research in Qualitative Analysis 3(3,0)

M B A 817 Business Forecasting Techniques and Applications 3(3,0) Study of forecasting techniques and their application for developing and assessing forecasts. Topics include economic data sources, multiple regression and time series analysis, and interpretation of forecasts for management and other clients. *Prreq:* M B A 802 and 803, or equivalent.

M B A 819 Introduction to Accounting and Finance 3(3,0) 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 MBA students lacking background in accounting and finance. *Prreq:* Consent of MBA director.

M B A 820 Globalization and Macro Markets 3(3,0) Operation of international markets, factors that determine exchange rates and influence trade, role of government and non-government organizations on economic outcomes, structured financial products to reduce international business risk. *Prreq:* Consent of instructor.

M B A 826 Business Marketing 3(3,0) Strategic marketing as it applies to industrial, organizational and institutional markets; consumer marketing versus business-to-business marketing; current business marketing literature and practices. *Prreq:* Principles of marketing or equivalent or consent of instructor.

M B A 828 Services Marketing 3(3,0) 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. *Prreq:* Principles of marketing or equivalent or consent of instructor.

M B A 829 Marketing Foundations 2(2,0) Principles and concepts involved in planning, pricing, promoting and distributing goods and services. *Prreq:* Consent of MBA director.

M B A 831 Communications and Sales 2(2,0) Students learn the principles of effective business communication, with a focus on delivering presentations and persuasive business pitches. Entrepreneurs also learn how to adapt a message to a variety of audiences, including investors, employees and customers.

M B A (FIN) 832 International Financial Management 3(3,0) 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. *Prreq:* M B A 807 or 857 or consent of instructor.

M B A 833 Real Estate Investments 3(3,0) Study of real estate investment analysis and decision making featuring the use of the discounted cash flow model and other tools to evaluate investment alternatives from the perspective of an equity real estate investor. Emphasizes market analysis, ownership alternatives and financing considerations. *Prreq:* M B A (FIN) 836.

M B A 834 Business Plan Capstone 3(3,0) Students finalize business plans and deliver presentations to a group of business leaders who may award up to \$100,000 as seed capital.

M B A 835 Investment Management 3(3,0) Discusses current techniques and strategies in the analysis of various investment alternatives. Includes portfolio management with an introduction to options and futures markets. *Prreq:* Principles of accounting and a demonstrated proficiency in basic finance.

M B A (FIN) 836 Real Estate Principles 3(3,0) Advanced survey course to acquaint students with the theories, practices and principles of real estate. Topics include urban economics, real estate law, brokerage, real estate valuation, financial institutions, tax issues, investment analysis, and development. *Prreq:* M B A 807 or 819 or consent of instructor.

M B A 837 Legal Environment of Business 2(2,0) 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; international legal considerations as these topics relate to business concerns. May not be used for credit toward a graduate degree. *Prreq:* Consent of MBA director.

M B A 839 Business Negotiations and Legal Dispute Resolution 3(3,0) 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. *Prreq:* M B A 837, 838 or consent of instructor.

M B A 840 Entrepreneurship and Venture Management 2(2,0) Prepares students for the challenges of managing human resources and organizational behavior at a new business venture. Students learn about the psychological drivers of employee behavior and understand how to manage employees in a start-up business environment.

M B A 841 Real Estate Finance 3(3,0) The application of financial analysis and theory to real estate, mortgage credit analysis and current financing techniques for residential and commercial properties is emphasized. Topics include financial institutions, mortgage financing techniques, financial decisions and construction financing. *Prreq:* M B A (FIN) 836.

M B A 842 Real Estate Valuation 3(3,0) Study of real estate appraisal with primary emphasis on two student projects: a house appraisal and a commercial property appraisal. Topics include highest and best use analysis, the three approaches to value, advanced capitalization techniques, discounted cash flow analysis and the standards of professional practice. *Prreq:* M B A (FIN) 836.

M B A 843 Entrepreneurial Accounting 2(2,0) An introduction to basic accounting principles. Students learn to analyze financial statements, understand GAAP, and comprehend double-entry bookkeeping from the perspective of a manager of a new business venture.

M B A 844 Entrepreneurial Law 1(1,0) Exposes students to issues ranging from registering a business to protecting intellectual property. Students also learn about the fundamental concepts of business law relating to tort law, contract law, liability law and business taxation.

M B A (MGT) 845 Technology and Innovation Management 3(3,0) Interdisciplinary examination of problems and issues in integrating technology and innovation into processes and products; evaluating tangible and intangible aspects of new technology adoption; management research and development; and functional integration of marketing and operations.

M B A 846 Use of Derivatives in Financial Engineering 3(3,0) 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. *Preq:* M B A 807 or 867 or consent of instructor.

M B A 847 New Venture Creation 2(2,0) Students work to set up a new venture, build networks and create a business plan while understanding how to identify and exploit opportunities.

M B A 848 Entrepreneurial Marketing and Digital Strategies 3(3,0) Students learn basic marketing principles and digital strategies, including Web optimizations and social media strategies. Entrepreneurs also learn about electronic commerce and the economics of digital business.

M B A 849 Entrepreneurial Strategy 3(3,0) Employs a case-based approach, focusing on the strategies employed by companies in a variety of industries. By extension, entrepreneurs utilize strategic frameworks to understand the external and internal forces that may impact their own venture.

M B A 850 Business Communications 1(1,0) Techniques, skills, problems and approaches for effective business communications; strengths and weaknesses of various communications forms with concentration on informative and persuasive models. Includes practical experience in written work and presentations, video and verbal feedback, teamwork, problem solving and situational presentations. To be taken Pass/Fail only. *Preq:* Consent of MBA director.

M B A 851 Business Operations and Logistics 1(1,0) Entrepreneurs learn to understand the fundamentals of operations strategy to achieve efficient organizational performance and effective use of resources in their new business ventures.

M B A 852 Social Entrepreneurship 1(1,0) Social Entrepreneurship is the study of sustainability, hybrid entrepreneurship principles and the role of start-up companies as social ventures.

M B A 854 Managerial Accounting 3(3,0) Analysis, interpretation and use of accounting information for planning and control in business and nonbusiness organizations. Includes profit planning, budgeting and standards; product and segment costing and evaluation; and case studies and computer-based assignments. Offered spring semester only. *Preq:* M B A 819 or equivalent or consent of instructor.

M B A 859 Managerial Decision Modeling 3(3,0) Survey of decision modeling techniques useful in managerial decision making, including linear programming, project management, queuing models, transportation problems and Monte Carlo simulation. *Preq:* Consent of MBA director.

M B A 860 Advanced Marketing Strategy 3(3,0) Advanced marketing theory and critical thinking skills applied to support strategic decision making. Data analysis and advanced marketing models are employed with emphasis on building analytic and assessment skills. Offered spring semester only. *Preq:* M B A 858 or MKT 865 or consent of instructor.

M B A (MGT) 861 Information Systems 3(3,0) The critical role of information systems in contemporary business organizations; key information systems and technologies; their impacts both within and across organizational settings.

M B A 862 Managerial Economics 3(3,0) Use of economic analysis in managerial decision making. Topics include the theory of cost, production, industrial organization, coordination and control of the firm, from theoretical concepts to actual decision making. Offered fall semester only. *Preq:* Consent of MBA director.

M B A 863 Advanced Managerial Economics 3(3,0) Advanced economic analysis for managerial decision making. Topics include advanced price theory, theory of firm, internal organization of the firm, the economics of strategic behavior in the market and the empirical estimation of demand and cost functions. *Preq:* M B A 862 or consent of instructor.

M B A 870 Strategic Management 3(3,0) Investigation of the ongoing process of positioning a firm for competitive advantage in its changing business environment focusing on the role of general managers in formulating and implementing strategies for single and multibusiness firms. Business cases, class discussions and group projects are used to integrate content from previous business courses. Offered spring semester and summer session only. *Preq:* M B A 807, 809, 838, 854, 856, 861, 862; or consent of instructor.

M B A 871 Programming and System Development 3(3,0) Programming concepts and structures in developing information systems applications. Specific techniques and tools covered are updated to incorporate the newest technologies. *Preq:* Consent of instructor.

M B A 872 Entrepreneurial Finance 3(3,0) Topics include business valuation, financial forecasting, financing strategies and business harvesting. Includes case studies and computer modeling. *Preq:* ECON 855 or M B A 807.

M B A (MGT) 874 Managing Continuous Improvement 3(3,0) 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. *Preq:* MGT 803 or consent of instructor.

M B A 875 Enterprise Development 3(3,0) Studies the 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 Sustainable Business Practices 3(3,0) Examination of emerging field of sustainable business practices and its role in strategy development and implementation. Specific emphasis is on history, science and politics of sustainability, including its effects on production, consumption and environmental impact. *Preq:* Consent of instructor.

M B A 880 MBA Seminar 1-3(1-3,0) Presents various topics, such as professional development for MBA students, project research methods for graduate research assistants, and other special topics. To be taken Pass/Fail only. May be repeated for a maximum of four credits. *Preq:* Consent of instructor.

M B A 881 Seminar on Ethics and Leadership 1(1,0) Exposes MBA students to various ethical, leadership and personal development venues through a combination of speakers, networking activities, workshops, competitions, personal development exercises and other related activities. May be repeated for a maximum of two credits. To be taken Pass/Fail only. *Preq:* Consent of instructor.

M B A 888 Internship in Business Administration 2-6 Preplanned, preapproved, faculty-supervised internship designed to give students on-the-job learning in support of classroom education. A two-credit hour internship must be no fewer than 120 contact hours (e.g., four weeks, 30 hours per week; or eight weeks, 15 hours per week; or 15 weeks, eight hours per week) with the same internship provider. To be taken Pass/Fail only. May be repeated for a maximum of six credits. *Preq:* Thirty semester hours of graduate credit and consent of MBA director.

M B A 899 Selected Topics in Business Administration 1-6(1-6,0) 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 a maximum of nine credits.

CAREER AND TECHNOLOGY EDUCATION

CTE (ED) 700 Supervising the Student Teacher in the Public School 2-3(2-3,0) See ED 700.

CTE (H R D) 845 Needs Assessment for Education and Industry 3(3,0) See H R D 845.

CTE (H R D) 847 Instructional Systems Design 3(3,0) See H R D 847.

CTE (H R D) 860 Instructional Materials Development 3(3,0) See H R D 860.

CTE 865 American Industries 3(3,0) Concepts and principles of American industry and technology. Industrial plant visits supplement study of industrial organization, economics, management, production and products.

CTE (H R D) 870 Consulting for Education and Industry 3(3,0) See H R D 870.

CTE (AG ED, ED) 889 Research in Education 3(3,0)
See AG ED 889.

CTE 895 Special Problems I 3(3,0) Special problems in industrial education varying with interests, experiences and needs of students. *Preq:* Submission of a written proposal, completion of nine hours in the major and consent of advisor.

CTE 896 Special Problems II 3(3,0) Continuation of CTE 895. *Preq:* CTE 895, written proposal and consent of advisor.

CHEMICAL ENGINEERING

CH E 601 Transport Phenomena 3(3,0) Mathematical analysis of single and multidimensional steady-state and transient problems in momentum, energy and mass transfer. Both the similarities and differences in these mechanisms are stressed. *Preq:* CH E 312, MTHSC 208.

CH E 612 Polymer Engineering 3(3,0) Design-oriented course in synthetic polymers. Topics include 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. *Preq:* CH 224 and 332 or consent of instructor.

CH E 645 Selected Topics in Chemical Engineering 3(3,0) Topics not covered in other courses, emphasizing current literature, research and practice of chemical engineering. Topics vary from year to year. May be repeated, but only if different topics are covered. *Preq:* Consent of instructor.

CH E 650 Chemical Reaction Engineering 3(3,0) Review of kinetics of chemical reactions and an introduction to the analysis and design of chemical reactors. Topics include homogeneous and heterogeneous reactions, batch and continuous flow reaction systems, catalysis, and design of industrial reactors. *Preq:* CH E 312, 321, CH 332.

CH E 803 Advanced Transport Phenomena 3(3,0) Analysis of heat, mass and momentum transfer; derivation and application of the governing equations; solution of steady and unsteady-state multidimensional problems in fluid flow, heat transfer and mass transfer.

CH E 804 Chemical Engineering Thermodynamics 3(3,0) Study of equilibria of physical and chemical systems and generalized properties of hydrocarbons. Includes application of thermodynamic methods in equipment design.

CH E 805 Chemical Engineering Kinetics 3(3,0) Kinetics of chemical reactions, particularly in design and operation of chemical reactors.

CH E (EE&S) 814 Applied Numerical Methods in Process Simulation 3(3,0) 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 are reviewed. *Preq:* Consent of instructor.

CH E 818 Polymer Processing 3(3,0) 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 823 Mass Transfer and Stagewise Contact Operations 3(3,0) Stagewise contact operations emphasizing distillation; vapor-liquid equilibria; integral and differential distillation; binary and multicomponent rectification; analytical methods; batch rectification; azeotropic and extractive distillation.

CH E 834 Advanced Chemical Engineering Thermodynamics 3(3,0) Classical and statistical thermodynamics applied to problems in chemical engineering emphasizing 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 polydispersed systems, computer simulation of fluids by Monte Carlo, molecular dynamics and stochastic dynamics methods. *Preq:* CH E 804 or equivalent.

CH E 845 Selected Topics in Chemical Engineering 3(3,0) Topics not covered in other courses emphasizing current literature and results of current research. Topics vary from year to year to keep pace with developments. May be repeated for credit.

CH E 890 Special Projects 1-6 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. To be taken Pass/Fail only. *Preq:* Consent of instructor and department chair.

CH E 891 Master's Thesis Research 1-12

CH E 895 Chemical Engineering Graduate Seminar 1(1,0) Series of weekly, one-hour seminars given by students, faculty and guests on topics of current interest. Credits earned in this course do not apply to or alter the required minimum of six research hours for the MS degree or the required 30 research credit hours for the PhD degree. To be taken Pass/Fail only.

CH E 945 Selected Topics in Chemical Engineering 3(3,0) More comprehensive study of topics first covered in CH E 845.

CH E 991 Doctoral Dissertation Research 1-12

CHEMISTRY

CH 602 Inorganic Chemistry 3(3,0) Basic principles of inorganic chemistry are discussed with special emphasis on atomic structure, chemical bonding, solid state, coordination chemistry, organometallic chemistry, and acid-base theories. The chemistry of certain selected elements is treated. Offered fall semester only. *Preq:* CH 331, 332.

CH 604 Bioinorganic Chemistry 3(3,0) Covers fundamentals of bioinorganic chemistry with review of necessary inorganic and biochemical concepts. Topics include metal uptake, transport and storage in biological systems; functions of metals in proteins; metal ion interactions with nucleic acids; physical methods used in bioinorganic chemistry; heavy element toxicity, radiopharmaceuticals and other metallodrugs. *Preq:* BIOCH 301 or CH 205.

CH 611 Instrumental Analysis 3(3,0) Principles of operation and application of modern chemical instrumentation in the field of analytical chemistry. Topics include basic electronics, statistics, optical, mass, magnetic resonance, electron and x-ray spectroscopies, radiochemistry, and separation science. *Preq:* CH 331, 332.

CH 614 Bioanalytical Chemistry 3(3,0) Survey of selected areas of importance in bioanalytical chemistry. Includes fundamental principles, advanced topics and applications of analytical measurements of biomolecules, bioassays, immunoassays, separations, mass spectrometry, method validation, macromolecular crystallography, microscopy and imaging. *Preq:* CH 313, 411, or consent of instructor.

CH 621 Advanced Organic Chemistry 3(3,0) Survey of modern organic chemistry with an emphasis on synthesis and mechanisms. *Preq:* CH 224, 332 or equivalent.

CH 625 Medicinal Chemistry 3(3,0) Survey of the pharmaceutical drug discovery process. Covers discovery of candidate compounds; bioassay methods; associated regulatory and commercial issues. Case studies are selected from the current literature. *Preq:* CH 224 or equivalent or consent of instructor.

CH 627 Organic Spectroscopy 3(2,3) Survey of modern spectroscopic techniques used in the determination of molecular structure. Emphasis is on the interpretation of spectra: nuclear magnetic resonance, ultraviolet, infrared, mass spectroscopy, optical rotatory dispersion and circular dichroism. *Preq:* One year each of organic chemistry and physical chemistry.

CH 635 Atomic and Molecular Structure 3(3,0) Introduction to quantum theory and its application to atomic and molecular systems. Topics include harmonic oscillator, hydrogen atom, atomic and molecular orbital methods, vector model of the atom, atomic spectroscopy and molecular spectroscopy. Offered spring semester only. *Preq:* CH 332 or consent of instructor.

CH 651 Frontiers in Polymer Chemistry 3(3,0) Survey of selected areas of current research in polymer science with particular emphasis on polymer synthesis. Although a text is required for review and reference, course is primarily literature based and focused on areas of high impact to multidisciplinary technology. *Preq:* CH 223, 224, MS&E 415 or consent of instructor.

CH 671 Teaching Chemistry 3(3,0) Topics in chemistry addressed in the context of constructivist methodologies. Also considers laboratory work and management, laboratory safety and the use of technology in the chemistry classroom. *Preq:* 300-level chemistry course or high school teaching experience or consent of instructor.

CH 704 Selected Topics for Chemistry Teachers 1-6(1-6,1-6) Directed individual study in designing experiments and teaching materials or an in-depth study of one or more advanced topics. For graduate students in Elementary and Secondary Education. May be repeated, but only if different topics are covered. Offered spring semester of odd-numbered years only.

CH 800 Professional Development Issues in Chemistry 1(1,0) Covers development of professional behavior for graduate students in chemistry, including communication skills, teaching techniques, research ethics, career management, "grantsmanship," and intellectual property issues in science. *Preq:* Graduate standing in Chemistry.

CH 805 Theoretical Inorganic Chemistry 3(3,0) Application of group theory to structure and properties of inorganic molecules. Offered spring semester of odd-numbered years only. *Preq:* CH 435 and 804 or consent of instructor.

CH 807 Chemistry of the Transition Elements 3(3,0) Structure, spectroscopy and reactivity of transition metals and their compounds. Offered fall semester only. *Preq:* CH 804 or consent of instructor.

CH 808 Chemistry of the Nonmetallic Elements 3(3,0) Development and application of a bonding model for descriptive inorganic chemistry of boron, carbon, silicon, nitrogen, phosphorus, oxygen and sulfur. Offered spring semester of odd-numbered years only. *Preq:* CH 804 or consent of instructor.

CH 809 Chemical Applications of X-Ray Crystallography 3(2,2) Physical description of the crystalline state, symmetry in crystals, X-ray diffraction, modern methods of structure determination, and chemical interpretation of structural results. Offered spring semester of odd-numbered years only. *Preq:* CH 331 and 332 or consent of instructor.

CH 812 Chemical Spectroscopic Methods 3(2,3) 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(3,0) Theory and experimental study of electrochemical thermodynamics, electrified interfaces, interfacial charge transfer, electrolyte solutions, electrode processes, and membrane electrochemistry; amperometric, voltammetric, electrolytic and potentiometric methods; practical applications of electrochemistry in analysis, materials synthesis and energy technology. *Preq:* Graduate standing in Chemistry or Chemical Engineering or consent of instructor.

CH 814 Analytical Imaging 3(3,0) Covers fundamental principles and application of major imaging techniques, including light, electron and scanning probe microscopy, magnetic resonance imaging, and computer tomography. *Preq:* Physics, Physical Chemistry or equivalent; or consent of instructor.

CH 815 Mass Spectrometry 3(3,0) The fundamental and practical aspects of mass spectrometry are presented. Topics include vacuum technology, ion optics, mass analyzers, ionization techniques, and hyphenated methods. *Preq:* Graduate standing or consent of instructor.

CH 816 Separation Science 3(3,0) Fundamental thermodynamic and kinetic concepts of separation and practical aspects of current separation techniques used in analytical chemistry. Offered spring semester of odd-numbered years only.

CH 818 Surface and Thin Film Analysis 3(2,2) Fundamental principles underlying the most commonly employed techniques for surface and thin films analysis. Representative techniques include atomic force microscopy, scanning electron microscopy, secondary ion mass spectrometry, Auger electron spectroscopy and Rutherford back-scattering. Laboratory exercises give insights into analytical methods.

CH 821 Organic Chemistry I 3(3,0) Theoretical concepts of organic chemistry, stereochemistry and mechanisms of organic reactions. Offered fall semester only. *Preq:* CH 421 or satisfactory performance on the organic chemistry placement examination.

CH 822 Organic Chemistry II 3(3,0) Continuation of CH 821; mechanisms of organic reactions including photochemistry and Woodward-Hoffman rules; modern synthetic organic chemistry. Offered spring semester only. *Preq:* CH 821 or consent of instructor.

CH 830 Fundamentals of Physical Chemistry 3(3,0) Principles of classical thermodynamics, chemical kinetics and quantum chemistry. Offered fall semester only. *Preq:* CH 331 or equivalent.

CH 831 Chemical Thermodynamics 3(3,0) Classical thermodynamics emphasizing theory and significance of energetics and systems of variable composition. Offered fall semester of odd-numbered years only. *Preq:* CH 331 or equivalent.

CH 834 Statistical Thermodynamics 3(3,0) Study of statistical thermodynamics including ensemble method, ideal gases, internal degrees of freedom, solid state, imperfect gases, distribution function method in fluids, and time-dependent fluctuations. *Preq:* CH 831.

CH 835 Chemical Kinetics 3(3,0) 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 are supplemented by assigned problems, paper and oral examination of topic of special interest to the student. Offered spring semester of odd-numbered years only.

CH 837 Quantum Chemistry 3(3,0) 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. Offered fall semester of odd-numbered years only.

CH 838 Computational Chemistry 3(3,0) Theoretical methods and software used in computational chemistry; quantum chemical methods including molecular orbital methods and density functional theory; classical simulation techniques including potential energy functions, molecular mechanics, molecular dynamics and Monte Carlo. Advanced topics vary with interests of students. *Preq:* CH 331 and 332 or equivalent.

CH 840 Techniques of Experimental Chemistry 3(1,6) Theory and practice in major experimental techniques used in chemical research; chromatography; NMR, IR, visible, UV, and ORD/CD spectrophotometry; glassblowing and high vacuum techniques; mass spectrometry; ESR; Mössbauer spectrometry and tracer analysis.

CH 841 Chemical Applications of NMR Spectroscopy 3(2,2) Basic concepts of NMR spectroscopy with application to organic, inorganic, physical and analytical chemistry; design of spectroscopic experiments and interpretation of spectra; modern techniques including multipulse, multinuclear and two-dimensional methods. Offered fall semester only. *Preq:* CH 331 and 332 or consent of instructor.

CH (EE&S) 842 Actinide Chemistry 3(3,0) See EE&S 842.

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

CH 852 Departmental Seminar 1-2(1-2,0) 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. May be taken more than one semester. *Preq:* Approved bachelor's degree.

CH 860 Chemical Biology 3(3,0) Covers fundamentals of chemical biology by examining the structure, function, bonding and reactivity of nucleic acids, proteins, carbohydrates and lipids. Topics are covered from the perspective of organic, inorganic, analytic and physical chemistry. Credit will be given for only one of CH 860, BIOCH 631. *Preq:* Undergraduate coursework in organic, inorganic, physical and analytic chemistry; or consent of instructor.

CH 891 Master's Thesis Research 1-12

CH 900 Selected Topics in Inorganic Chemistry 1-4(1-4,0) Metal-metal bonding; homogeneous catalysis; photochemistry; bioinorganic chemistry; solid state chemistry. Topics vary with interests of students. May be repeated for credit if different topics are covered.

CH 910 Selected Topics in Analytical Chemistry 1-4(1-4,0) New techniques and their applications in analytical chemistry; laser methods; data acquisition processing; electronics, instrument/computer interfacing; field methods of sampling and analysis. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.

CH 920 Selected Topics in Organic Chemistry 1-4(1-4,0) Heterocyclic compounds; stereochemistry; natural products; organometallic chemistry; photochemistry. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.

CH 930 Selected Topics in Physical Chemistry 1-4(1-4,0) 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 1-12

CITY AND REGIONAL PLANNING

C R P 601 Introduction to City and Regional Planning 3(3,0) Introduces students from other disciplines to City and Regional Planning. Spatial and nonspatial areas of discipline are explored through a wide ranging lecture/seminar program. *Preq:* Consent of instructor.

C R P 603 Seminar on Planning Communication 3(3,0) In-depth analysis of methods to communicate planning and policy decisions effectively. Familiarizes students with the various communication skills needed by planners, policy makers and other professionals to become successful practitioners. *Preq:* Consent of instructor.

C R P (C E) 612 Urban Transportation Planning 3(3,0) See C E 612.

C R P 800 Human Settlement 3(3,0) Overview of forces and trends affecting community growth and change—historical, ecological, economic, demographic, design and development—pertaining to human settlement patterns and their interrelationship in the urbanization process, especially at the national, regional, townscape and neighborhood scale. Team-taught from various perspectives. Intended as a foundation core course for Master's in Real Estate Development, City and Regional Planning, and Landscape Architecture. *Preq:* Consent of instructor.

C R P 801 Planning Process and Legal Foundations 3(3,0) Introduction to the city and regional planning profession and related processes with the legal foundation for comprehensive planning and tools of implementation. *Preq:* Consent of instructor.

C R P 802 Site Planning and Infrastructure 3(3,0) Covers the principles and practice of site planning, including site analysis, site design, infrastructure planning; exploration of site planning options for residential, commercial, office, industrial and mixed-use projects; street network, civic space, and open space planning; emphasis on walkable, mixed-use, transit-oriented, sustainable development. *Preq:* Consent of instructor.

C R P 803 Quantitative Analysis 4(2,6) Basic tools of quantitative analysis and planning methods in the context of analytical, procedural and institutional needs of the planner. Students learn data collection, analysis and interpretation of different planning problems. Emphasis is placed on understanding the logic of statistical analysis, methods of planning analysis and policy formation. *Preq:* Consent of instructor.

C R P 804 Land Use Analysis and Assessment 4(2,6) Introduction to basic methods of land use planning including land suitability analysis, land market forecasts and formulating alternative land use plans. Development impact assessment and project appraisal methods are introduced to evaluate land use plans. *Preq:* C R P 803.

C R P 805 Planning Theory and History 3(3,0) Development of the planning practice and theories of planning process: historical evolution of planning practice in the U.S., social issues in planning, theories of planning and critiques of those theories and ethical issues in planning practice. *Preq:* Consent of instructor.

C R P 806 Urban Systems and Growth Management 3(3,0) Overview of basic principles of resource allocation including public finance and project appraisal techniques. Introduces infrastructure planning and capital improvement plans followed by basic concepts of growth management and an overview of growth management laws and tools. Course is team-taught to address diverse subject matter. *Preq:* Consent of instructor.

C R P 807 Professional Studio 4(1,9) Serves as a vehicle for synthesis and application of skills developed in other courses and includes participation in one or more real-world planning projects in addition to seminars and readings devoted to development of professional practice skills. *Preq:* Consent of instructor.

C R P 809 Current Issues in Planning 1(1,0) Students are exposed to current practice issues in various fields of the planning profession through a series of guest speakers representing various areas of planning practice. The course is organized around the various concentration areas of the Clemson MCRP program. *Preq:* MCRP status.

C R P 813 Fundamentals of Transportation Planning 3(3,0) Identifies issues and questions transportation planners face, characterizes policy shaping transportation, instructs on methods to solve transportation planning problems and portrays the political and organizational environment in which transportation planners operate. Students integrate concepts and considerations via a systems approach with sensitivity to the transportation planning environment. *Preq:* Consent of instructor.

C R P 814 Public Transit 3(3,0) Familiarizes students with core concepts and practices in public transit. Course modules examine modes and design, planning issues and organizational environments inherent to public transit, and technical operations. Course concludes with an examination of comprehensive transit systems. *Preq:* Consent of instructor.

C R P 815 Transportation Innovation 3(3,0) Through lectures, seminar discussions and collaborative learning activities, course interaction develops students' transportation knowledge, research and ideas. Students are encouraged to use information already obtained to create visionary thinking and interaction skills needed to become transportation leaders. *Preq:* C R P 813.

C R P 820 Negotiation and Development Dispute Resolution 3(3,0) Skill-building course in conflict resolution and consensus building through bargaining and negotiation, primarily in the design professions. Students play active roles in discovering, applying, reflecting on and critiquing the theories, styles and techniques of conflict resolution and consensus building that work in different types of disputes. *Preq:* Graduate standing in a design related field.

C R P 822 Urban Design 3(3,0) Urban design theory and practice covering both project design and regulatory frameworks; analysis of historical precedents and current theories; review of the urban design process, including urban landscape analysis, problem identification, development of alternatives, and plan generation; special focus on form-based codes. *Preq:* Consent of instructor.

C R P 834 Spatial Modeling Using GIS 3(2,3) Use of geographic information systems (GIS) in spatial analysis, information management and synthesis of spatial patterns and processes. Emphasizes developing an operational understanding of the modeling techniques and data used in different applications such as land use allocation, corridor location, site location and market analysis, environmental assessment and cost-benefit analysis. *Preq:* C R P 634 or 804; or consent of instructor.

C R P 835 GIS and Remote Sensing Applications for Trend Analysis 3(2,3) Principles of remote sensing and land information systems in trend analysis. Addresses aspects of change detection for monitoring natural resources and urban growth. Designed for those interested in planning, natural resources management and environmental analysis. Lectures and hands-on laboratory work emphasize the use of imagery for database generation and analysis. *Preq:* C R P 634, 804, or 834; or consent of instructor.

C R P 840 Seminar in Coastal Planning 3(3,0) Issues relating to development and conservation of coastal environments, focusing on inherent tradeoffs between growth and environmental quality. Discusses ecology and carrying capacity of coastal areas and appropriate management approaches to balance coastal resource demand. *Preq:* Consent of instructor.

C R P 841 Seminar in Environmental Planning 3(3,0) 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 research on an environmental issue of particular concern and report findings. *Preq:* Consent of instructor.

C R P (PRTM) 844 Outdoor Recreation Resource Management and Planning 3(3,0) 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. *Preq:* Consent of instructor.

C R P (PO ST) 845 Water Policy and Law 3(3,0) Surveys the history, science, economics, politics, legal framework and current debates regarding the allocation of freshwater resources in the U.S., with emphasis on relevant Southeastern issues. Scientists, engineers, planners, landscape architects, policy makers and economists will benefit from understanding water allocation and associated conflicts.

C R P 858 Research Design 3(3,0) Provides opportunity for students in their final year of study in the planning program to develop a proposal for the terminal project or thesis. Students are responsible for completing the research, writing and editing necessary for an acceptable proposal. *Preq:* Consent of faculty.

C R P 859 Planning Terminal Project 3(0,9) Students select, with approval of advisor, and conduct research on individual planning problems of suitable scope. Oral, written, and, where appropriate, visual presentations of solution are required. Students must enroll during final semester. *Preq:* C R P 858.

C R P (PO ST) 870 Seminar in Sustainable Development 3(3,0) See PO ST 870.

C R P 872 Housing Issues in the United States 3(3,0) Regulation, stimulation, salvage and replacement of housing through public policy administrative procedures. Specific housing programs are analyzed in detail. *Preq:* Consent of instructor.

C R P 873 Economic Development Planning 3(3,0)

Economic development planning process, focusing on applied programmatic techniques, especially at the state, local and neighborhood levels. Emphasizes theoretical models, economic development process, private/public partnerships, economic development tools, political context, and economic development planning administration and organization. *Preq:* Consent of instructor.

C R P 889 Selected Topics in Planning 3(3,0) Topics emphasizing current literature and results of current research. May be repeated for credit. *Preq:* Consent of instructor.

C R P 890 Directed Studies in City and Regional Planning 1-6(0,3-18) Students pursue individual professional interests under guidance of City and Regional Planning graduate faculty. May be repeated for credit.

C R P 891 Planning Thesis 6(0,18) Students, working individually, program a planning problem of appropriate scope and conduct research. Oral, written and, where appropriate, visual presentations of theses are required. To be taken Pass/Fail only. *Preq:* Consent of faculty.

C R P 893 City and Regional Planning Internship 1(0,3) Ten weeks of supervised professional employment with an approved planning entity. To be taken Pass/Fail only. *Preq:* Two semesters of City and Regional Planning or equivalent.

C R P 894 Planning Internship Seminar 1(1,0) Seminar-based analysis of student internships, enabling students to compare experiences and gain greater understanding of professional practice by reflecting on planning issues. To be taken Pass/Fail only. *Preq:* C R P 893.

CIVIL ENGINEERING

C E 601 Indeterminate and Matrix Structural Analysis 3(3,0) Analysis of indeterminate structures using moment distribution, energy methods such as virtual work and Castiglano's Theorem, and the matrix formulation of the direct stiffness method. *Preq:* C E 301 or consent of instructor.

C E 604 Masonry Structural Design 3(3,0) Introduction to design of structural elements for masonry buildings. Lintels, walls, shear walls, columns, pilasters and retaining walls are included. 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. *Preq:* C E 402 or consent of instructor.

C E 607 Wood Design 3(3,0) Introduction to wood design and engineering; properties of wood and wood-based materials; design of beams, columns, walls, roofs, panel systems and connections. *Preq:* C E 402 or 406, or consent of instructor.

C E 608 Structural Loads and Systems 3(3,0) In-depth discussion of minimum design loads and load combinations. Includes overview of various steel and concrete systems. Discusses practical selection and design issues and design of proprietary building materials and components such as steel joists, diaphragms, engineered wood products, etc. *Preq:* C E 206, 301.

C E 610 Traffic Engineering Operations 3(3,0) 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. *Preq:* C E 311 or consent of instructor.

C E 611 Roadway Geometric Design 3(2,3) Geometric design of roadways, at-grade intersections, and interchanges in accordance with conditions imposed by driver ability, vehicle performance, safety and economics. *Preq:* C E 311 or consent of instructor.

C E (C R P) 612 Urban Transportation Planning 3(3,0) Urban travel characteristics, characteristics of transportation systems, transportation and land-use studies, trip distribution and trip assignment models, city patterns and subdivision layout. *Preq:* C E 311 or consent of instructor.

C E 621 Geotechnical Engineering Design 3(3,0) Relationship of local geology to soil formations, groundwater, planning of site investigation, sampling procedures, determination of design parameters, foundation design and settlement analysis. *Preq:* C E 321 or consent of instructor.

C E 624 Earth Slopes and Retaining Structures 3(3,0) Principles of geology, groundwater and seepage, soil strength, slope stability and lateral earth pressure and their application to the design of excavations, earth fills, dams and earth-retaining structures. *Preq:* C E 321 or consent of instructor.

C E 633 Construction Planning and Scheduling 3(3,0) 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. *Preq:* C E 331 or consent of instructor.

C E 634 Construction Estimating and Project Control 3(3,0) Study of 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. *Preq:* C E 331 or consent of instructor.

C E 635 Infrastructure Project Planning 3(3,0) Covers concepts related to planning, cost estimating, financing and executing public works projects from the agency owner perspective. Advanced concepts of engineering economic analysis, risk analysis and database management systems are addressed. Traditional and innovative project contracting strategies, including incentive contracts and public-private partnerships, are discussed. *Preq:* C E 352.

C E 636 Sustainable Construction 3(3,0) Presents the "why," "what" and "how" for sustainable construction projects. Students gain a working understanding of how to minimize the negative impacts of buildings and other large construction projects. *Preq:* C E 331 or consent of instructor.

C E 638 Construction Support Operations 3(3,0) Describes 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. *Preq:* C E 331 and EX ST 301, or consent of instructor.

C E 643 Water Resources Engineering 3(3,0) Extension of the concepts of fluid mechanics to applications in water supply, water resource assessment, water transmission, water distribution networks, pump and pipe selection, pipe networks and analysis of open channel appurtenances. *Preq:* C E 341.

C E 646 Flood Hazards and Protective Design 3(3,0) Study of 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 are discussed. Includes case studies and design projects. *Coreq:* C E 342 or consent of instructor.

C E 647 Stormwater Management 3(3,0) Evaluation of peak discharges for urban and rural basins, design of highway drainage structures such as inlets and culverts; stormwater and receiving water quality; best management practices; detention and retention ponds; and erosion and sediment control. *Preq:* C E 342. *Coreq:* EE&S 202 or 401; or consent of instructor.

C E 656 Pavement Design and Construction 3(3,0) Introduction to design methods, construction practices, maintenance strategies and decision making process related to pavements. Other topics, such as environmental considerations and special pavement types and materials, are also covered. *Preq:* C E 311 and 351 or equivalent; *Coreq:* C E 321 or equivalent.

C E 657 Materials Testing and Inspection 3(3,0) Introduction to the role of testing and inspection professionals in civil engineering projects. Uses a practical approach to applying concepts to real-world situations through the completion of several team projects such as material characterization, construction QC/QA, forensic evaluation and proposal development. *Preq:* C E 321 and 351 or equivalent.

C E 662 Coastal Engineering I 3(3,0) Introduction to 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. *Preq:* C E 341 or consent of instructor.

C E 682 Groundwater and Contaminant Transport 3(3,0) Basic principles of groundwater hydrology and transport of contaminants in groundwater systems; groundwater system characteristics; steady and transient flow; well hydraulics, design and testing; contaminant sources, movement and transformations. *Preq:* C E 341. *Coreq:* EE&S 202 or 401; or consent of instructor.

C E 691 Selected Topics in Civil Engineering 1-6(1-6,0) 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. *Preq:* Consent of instructor.

C E 801 Finite Element Analysis 3(3,0) Finite element methods in solution of engineering problems; stiffness matrices for bar, beam, triangular, rectangular and quadrilateral elements in planer systems; plate bending, shell and 3-D elements; applications to solutions of structural and soil mechanics problems using special and general purpose programs. *Preq:* C E 401 or consent of instructor.

C E 802 Advanced Reinforced Concrete Design 3(3,0) Second course in design of reinforced concrete structures; advanced concepts in analysis and design of beams, columns, shear walls and slabs; introduction to the seismic design of concrete structures. *Preq:* C E 402 or consent of instructor.

C E 803 Advanced Steel Design 3(3,0) Advanced design of structural steel buildings emphasizing the relationship between design and response of the structural system. Includes theoretical basis of building code provisions, limit state design, beam-columns, plate girders and composite sections and connections. Also includes the seismic design of steel structures. *Preq:* C E 406 or consent of instructor.

C E 804 Prestressed Concrete 3(3,0) Introduction to the analysis, behavior and design of prestressed concrete members and structures. Covers allowable stress design and strength design of P/C members, shear design, loss of prestress force, design of continuous structures. *Preq:* C E 401 and 402, or consent of instructor.

C E 805 Advanced Structural Mechanics 3(3,0) 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; and introduction to finite element analysis. *Preq:* C E 301 or consent of instructor.

C E 806 Dynamic Analysis of Structures 3(3,0) Analysis of structures subjected to dynamic loading; response of lumped and distributed parameter systems of one or many degrees of freedom; and introduction to earthquake analysis, including modal and time history analysis. *Coreq:* C E 401 or consent of instructor.

C E 807 Wind Engineering 3(2,2) 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(3,0) 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. Includes an introduction to performance-based seismic design concepts and displacement-based design methods. *Preq:* C E 806 or consent of instructor.

C E 813 Highway and Airport Pavement Design 3(3,0) 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. *Preq:* C E 311, 321, and 351; or consent of instructor.

C E 814 Intelligent Transportation Systems 3(3,0) Students learn concepts of Intelligent Transportation Systems (ITS), including traffic flow principles, advanced traffic sensor and communications technologies and real-time management strategies, to increase the safety and efficiency of the surface transportation system. Covers the process of planning, design and operations of ITS. *Preq:* Consent of instructor.

C E 815 Transportation Safety Engineering 3(3,0) 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. *Preq:* C E 311 or consent of instructor.

C E 820 Geotechnical Site Characterization 3(3,0) Study of advanced methods of subsurface investigation for design of civil structures in soil and rock. Includes field reconnaissance, interpretation of geologic maps and cross sections, drilling, in situ testing, sampling, characterization of soil and rock formations and selection of engineering properties. *Preq:* C E 321 or equivalent.

C E 821 Advanced Soil Mechanics 3(3,0) Study of stresses in soils, stress-strain and shear strength properties of soil, plastic equilibrium of soil masses, failure conditions, earth pressures, with applications to geotechnical engineering design. *Preq:* C E 321 or consent of instructor.

C E 822 Foundation Engineering 3(3,0) 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. *Preq:* C E 321 or consent of instructor.

C E 823 Asphalt Concrete Properties 3(3,0) Includes identification and suitability of aggregates for construction. Covers characteristics and properties of bituminous materials and materials behavior, construction and design problems. Requires use of microcomputers and the mainframe. *Preq:* C E 351 or consent of instructor.

C E 825 Soil Dynamics and Geotechnical Earthquake Engineering 3(3,0) 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. *Preq:* C E 321 or consent of instructor.

C E 826 Properties of Portland Cement Concrete 3(3,0) Material science and engineering of Portland cement concrete. Topics include physical and chemical properties of cements; mixture proportioning; mixing; placement; curing techniques; specifications, tests and evaluation of fresh and hardened concrete; durability issues; and considerations in specialized applications. *Preq:* C E 351 or consent of instructor.

C E 827 Special Cements and Concrete 3(3,0) Study of material science and engineering aspects of specialty concretes that are used in unique civil engineering applications, including high-strength concrete, high performance concrete, highly flowable concrete, underwater concrete, shotcrete and others. Exposes students to properties and applications of specialty cements and admixtures that are often used in these special applications. *Preq:* C E 826 or equivalent.

C E 828 Repair and Rehabilitation of Concrete Structures 3(3,0) Provides students with a knowledge of different types of failures in concrete associated with material durability, construction and design (load) related failures. Also provides knowledge to identify, assess and remediate damage in concrete pavements and structures. Introduces the concepts and tools related to structural health monitoring. *Preq:* C E 826 or equivalent.

C E 829 Geosynthetics 3(3,0) Study of geosynthetics including geotextiles, geogrids, geomembranes, geonets, geosynthetic clay liners, geopipe and geocomposites which are used in many aspects of civil engineering for soil structures, retaining walls, pavement construction and rehabilitation, drainage, filtration and containment facilities. Covers production of geosynthetics, material properties, design aspects and field installation. *Preq:* C E 321 and 351 or their equivalents.

C E 832 Capital Project Management Fundamentals 3(3,0) Fundamental concepts of designing and constructing capital projects: what they are, why they are done, who is involved and how to best design and build them; phases of a capital project; and variations of organizational and contractual structures used for capital projects. *Preq:* Consent of instructor.

C E 833 Capital Project Controls 3(3,0) Principles and best practices of project controls for capital construction projects, including conceptual and detail estimating, scheduling and earned value management (EVM); development of project baseline incorporating scope, schedule and budget; use of baseline to monitor and manage cost and schedule performance; and shortcomings of EVM. *Preq:* C E 832 and consent of instructor.

C E 834 Key Topics in Capital Project Management 3(3,0) Investigates key topics associated with planning and managing capital construction projects, how these topics are integrated into a capital construction project management plan that achieves business and project objectives and how the project team uses the project management plan to successfully complete the construction project. *Preq:* C E 832 and consent of instructor.

C E 835 Construction Project Modeling 3(3,0) Mathematical and computer models are used to simulate construction operations. Covers linear models and optimization applications to construction materials, scheduling and equipment allocation; typical computer models used in construction using simple modeling examples. *Preq:* C E 331 or consent of instructor.

C E 836 Civil Engineering Quality Management 3(3,0) Principles of total quality management (TQM) and their applications in the engineering and construction industry; TQM implementation techniques emphasizing the construction environment; concepts of quality assurance (QA) and quality control (QC) in construction.

C E 837 Construction Specifications and Contracts 3(3,0)

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. *Prreq:* C E 331 or consent of instructor.

C E 838 Materials Management 3(3,0)

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. *Prreq:* Consent of instructor.

C E 839 Sustainable Infrastructure Systems 3(3,0)

Covers sustainable infrastructure systems with emphasis on science-based tools to design and analyze these systems. Examines theoretical background and specific cases for topics including life-cycle assessment, systems analysis and economic valuation for sustainability. *Prreq:* C E 436 or consent of instructor.

C E 840 Project Management Applications 3(3,0)

Quantitative tools for effective management and control of engineered projects from design through construction; cost coding and control, advanced schedule management techniques and quality management principles; extensive hands-on use of the microcomputer. *Prreq:* C E 433 and 434, or consent of instructor.

C E 846 Flow in Open Channels 3(3,0)

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. *Prreq:* C E 342 or consent of instructor.

C E 851 Reliability 3(3,0)

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.

C E 853 Applications in Traffic Engineering 3(2,3)

Highway capacity analysis; design of unsignalized intersections; intelligent transportation systems; parking; traffic signal coordination; microscopic and macroscopic traffic simulation. *Prreq:* C E 410 or consent of instructor.

C E 854 Travel Demand Forecasting 3(2,3)

In-depth coverage of travel-demand forecasting theory and the four-step process; site impact analysis; disaggregate demand models. Students work in groups to develop a computer-based travel forecasting model for a small city. *Prreq:* C E 412 or consent of instructor.

C E 855 Transportation Seminar 1(1,0)

Practical discussion of the transportation profession featuring faculty and off-campus experts. Course is highlighted by a retreat where students present their transportation research.

C E 860 Advanced Fluid Mechanics 3(3,0)

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(3,0)

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. *Prreq:* C E 342 or consent of instructor.

C E 868 Environmental Fluid Mechanics and Hydraulics 3(3,0)

Study of turbulence and basic flow equations as they impact the environment. Includes slender flows including circular and plane turbulent jets, jets in crossflows, wall, surface jets and plumes; near-field and far-field analysis of discharge in rivers including continuous momentum discharges, nonbuoyant plumes and passive slugs; mixing in lakes and reservoirs; and stratified flows.

C E 875 Numerical Models in Hydraulics 3(3,0)

Students learn applications of numerical modeling, finite difference, finite volume and finite element, as tools for solving complex problems in the areas of hydraulics/fluid mechanics. Students learn techniques of developing and analyzing computational models for parabolic, elliptic and hyperbolic equations used in the area of hydraulics. *Prreq:* C E 342 or consent of instructor.

C E 889 Special Problems I 1-3

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

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 1-12

C E 893 Selected Topics in Civil Engineering 1-6(1-6,1-6)

Topics not covered in other courses. May be repeated for credit.

C E 991 Doctoral Dissertation Research 1-12

COLLEGE OF ENGINEERING AND SCIENCE

CES 603 Career Success in Research and Development 1(1,0)

Assists students in making personal and professional transition into industrial research careers. Offers advice and introduces and demonstrates practical techniques to help students avoid early career land mines. *Prreq:* Junior standing in engineering or science discipline.

COMMUNICATION STUDIES

COMM (ENGL) 651 Film Theory and Criticism 3(2,3)

See ENGL 651.

COMM 664 Advanced Organizational Communication 3(3,0)

Application of communication theory and research to the analysis of particular organizational communication processes. Students study significant issues and/or methods of intervention and innovation in organizational communication. *Prreq:* COMM 364 or consent of instructor.

COMM 670 Communication and Health 3(3,0)

Considers institutional and health-care communication issues as well as the relationship between social issues, communication and health. *Prreq:* COMM 201 with a C or better or consent of instructor.

COMM (ENGL) 691 Classical Rhetoric 3(3,0)

See ENGL 691.

COMM (ENGL) 692 Modern Rhetoric 3(3,0)

See ENGL 692.

COMM 800 Communication Pedagogy 1(1,0)

Development of teaching skills within the field of Communication Studies, focusing on teaching general education courses. Explores the facilitation of a positive classroom environment, addressing student needs, and evaluation of student work. Discussion of teaching philosophy and pedagogy.

COMM 801 Communication Theory I 3(3,0)

Explores the history, development and current state of scientific theories related to the study of human communication. Covers social and scientific traditions of theory. Students gain an understanding of metatheory and its relationship to historical and contemporary forms of theorizing about human communication.

COMM 802 Communication Theory II 3(3,0)

Surveys theories and analytic concepts used in the pluralistic field of Communication Studies. Draws on qualitative, rhetorical, critical, aesthetic, and humanistic traditions. May include, but is not limited to, social theory, interpretive criticism, feminism, sound studies, aesthetics, queer theory, cultural studies, and philosophy. Emphasis is on applications to social media studies.

COMM 803 Survey of Communication Technology Studies 3(3,0)

Surveys the approaches to researching uses, meanings, and effects of contemporary communication technologies in the pluralistic field of Communication Studies (e.g., interpersonal, small groups, policy, globalization, organizations, history, sustainability, infrastructure, children and media, cultural studies, networks), drawing on social scientific and humanistic traditions.

COMM (ENGL) 804 Fundamentals of Health Communication 3(3,0)

See ENGL 804.

COMM 805 Communication and Social Movements 3(3,0)

Examines arguments, tactics, and structures of social movements from discursive, rhetorical, social perspectives in the field of communication studies. Using case studies, questions of history, external and internal rhetoric, control and adaptation are considered. Movements as diverse as feminism, environmentalism, alternative globalization, and various rights-oriented movements may be considered.

COMM (ENGL) 807 Health Communication Campaign Planning and Evaluation 3(3,0)

See ENGL 807.

COMM 808 Representation and Popular Culture 3(3,0)

Seminar explores how popular culture artifacts represent various groups of people based on such characteristics as race, class, gender, sexuality, nationality, etc. A range of theoretical perspectives are incorporated, including but not limited to race theory, feminist theory, queer theory, postcolonialism and hegemonic masculinity theory.

COMM (ENGL) 809 Communication, Culture and the Social Net 3(3,0) Seminar explores communication and cultural practices that are evolving around social media.

COMM 810 Communication Research Methods I 3(3,0) Explores methods of social scientific research methodologies. Methods range from experimental designs to survey and cross sectional designs. Final projects include the employment of one or more methodologies to create a communication-based research proposal.

COMM 811 Communication Research Methods II 3(3,0) Explores select issues in and methods for qualitative research. Students discuss and practice data gathering and analysis techniques associated with ethnographic, interview, and textual approaches. Particular attention is given to research technologies.

COMM 827 Sports Media 3(3,0) Explores the history, forms and trends in sports media from a communication perspective, and examines the impact and influence of sport in society, identifying current and future trends in digital media.

COMM (A A H, ENGL) 840 Selected Topics 3(3,0)
See ENGL 840.

COMM (ENGL) 850 Research and Studies in Scientific, Business and Technical Writing 3(3,0)
See ENGL 850.

COMM 856 Trends in Public Relations Theory and Research 3(3,0) Seminar surveys the major theoretical approaches to public relations, as well as major and recent trends in public relations research and theory development.

COMM 864 Communication and Organizing 3(3,0) Explores theoretical and research literature on human communication and organizing processes from numerous methodological perspectives. Topics may include organizational culture, organizational socialization, power and politics, identification and communication networks and technology.

COMM 869 Political Communication 3(3,0) Seminar examines various forms of political communication through the application of multiple critical methodologies. Participants become familiar with traditional public address scholarship and contemporary study of campaigns, policy, leadership, media and popular culture.

COMM 871 Leadership Communication 3(3,0) Develops ability and knowledge of communicative aspects of leadership. Students integrate theories and practices of persuasion, motivation and media to actualize a leadership vision. Students explore issues and research in ethical and intercultural applications, including implications of institutional structures and their impact on society.

COMM 874 Special Topics in Communication Studies 3(3,0) Varying topics within the field of communication studies. May be repeated for a maximum of six credits, but only if different topics are covered.

COMM 891 Master's Thesis Research 1-9(0,3-27) Students complete research toward production of a Master's thesis. A maximum of six hours may be applied toward a degree, though additional hours may be taken for credit. May be repeated for a maximum of nine credits. *Preq:* Successful completion of core program requirements and all additional courses as approved by the department director of graduate studies.

COMM 899 Independent Study 1-3(1-3,0) Students focus on special interests or projects in communication studies outside the scope of existing courses. May be repeated for a maximum of six credits. *Preq:* Consent of faculty member.

COMMUNITY AND RURAL DEVELOPMENT

C RD (AP EC) 611 Regional Impact Analysis 3(3,0) Techniques for analysis of the growth and decline of regions including economic-base theory, shift share, regional input-output, regional econometric models and fiscal impact models. *Preq:* AP EC 202 or ECON 211 and 212.

C RD (AP EC) 612 Regional Economic Development Theory and Policy 3(3,0) 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 are considered. *Preq:* AP EC 202 or ECON 211 or equivalent.

C RD 692 Case Study Project 3(3,0) Capstone course engaging students in in-depth case study projects in community and economic development. Designed to enhance professional development, career interests and practical experience. Students may participate in an internship, field experience, service learning activity, or investigation of a community, leadership, or economic development topic. *Preq:* C RD 336 and consent of instructor.

COMPUTER ENGINEERING

See courses listed under Electrical and Computer Engineering.

COMPUTER SCIENCE

CP SC 604 Computer Graphics Images 3(3,0) Theory and practice behind the generation and manipulation of two-dimensional digital images within a computer graphics context. Image representation and storage, sampling and reconstruction, color systems, affine and general warps, enhancement and morphology, compositing, morphing, non-photorealistic transformations. *Preq:* CP SC 212 and MTHSC 311; or D P A 401; or consent of instructor.

CP SC 605 Computer Graphics 3(3,0) Computational, mathematical, physical and perceptual principles underlying the production of effective three-dimensional computer graphics imagery. *Preq:* CP SC 212 and MTHSC 311, or D P A 401, or consent of instructor.

CP SC 606 General Purpose Computation on Graphical Processing Units 3(3,0) Instruction in the design and implementation of highly parallel, GPU-based solutions to computationally intensive problems from a variety of disciplines. The OpenCL language with inter-operable OpenGL components is used. Applications to models of physical systems are discussed in detail. *Preq:* CP SC 212 and MTHSC 206; or consent of instructor.

CP SC 611 Virtual Reality Systems 3(3,0) Design and implementation of software systems necessary to create virtual environments. Techniques for achieving real-time, dynamic display of photo-realistic, synthetic images are discussed. Includes hands-on experience with electromagnetically-tracked, head-mounted displays and requires, as a final project, the design and construction of a virtual environment. *Preq:* CP SC 405 with a C or better.

CP SC 612 Eye Tracking Methodology and Applications 3(3,0) Introduction to the human visual system; visual perception; eye movements; eye tracking systems and applications in psychology, industrial engineering, marketing and computer science; hands-on experience with real-time, corneal-reflection eye trackers, experimental issues. Final project requires execution and analysis of an eye tracking experiment. *Preq:* CP SC 360 or PSYCH 310 or MKT 431.

CP SC 614 Human and Computer Interaction 3(3,0) Survey of human and computer interaction, its literature, history and techniques. Covers cognitive and social models and limitations, hardware and software interface components, design methods, support for design, and evaluation methods. *Preq:* CP SC 212 and 215 with a C or better, or equivalent.

CP SC 616 2-D Game Engine Construction 3(3,0) Introduction to the tools and techniques necessary to build 2-D games. Techniques draw from subject areas such as software engineering, algorithms and artificial intelligence. Students employ techniques such as sprite animation, parallax scrolling, sound, AI incorporated into game sprites and the construction of a game shell. *Preq:* CP SC 212 and 215 with a C or better.

CP SC 619 Physically Based Animation 3(3,0) Physically based modeling and dynamic simulation techniques as used for the automatic description of motion and geometry for animation and computer graphics. A variety of approaches are explored, with a special emphasis on the use of particle-systems to represent complex phenomena. *Preq:* CP SC 405 or consent of instructor.

CP SC 620 Computer Security Principles 3(3,0) Covers principles of information systems security, including security policies, cryptography, authentication, access control mechanisms, system evaluation models, auditing and intrusion detection. Computer security system case studies are analyzed. *Preq:* CP SC 322 and 360 with a C or better.

CP SC 624 System Administration and Security 3(3,0) Topics related to the administration and security of computer systems are covered. Primary emphasis is placed on the administration and security of contemporary operating systems. *Preq:* CP SC 360 and 332 or 422 with a C or better.

CP SC 628 Design and Implementation of Programming Languages 3(3,0) Overview of programming language structures and features and their implementation. Control and data structures found in various languages are studied. Runtime organization and environment and implementation models are also included. *Preq:* CP SC 231, 350, and 360 with a C or better.

CP SC 655 Computational Science 3(3,0) Introduction to the methods and problems of computational science. Course uses problems from engineering and science to develop mathematical and computational solutions. Case studies use techniques from Grand Challenge problems. Emphasizes the use of networking, group development and modern programming environments. *Preq:* MTHSC 108, 311 and previous programming experience in a higher level language.

CP SC 662 Database Management Systems 3(3,0) Introduction to database/data communications concepts as related to the design of on-line information systems. Problems and solutions involving structuring, creating, maintaining and accessing multiple-user databases are presented and solutions developed. Comparison of several commercially available teleprocessing monitor and database management systems is made. *Preq:* CP SC 360.

CP SC 663 On-line Systems 3(3,0) In-depth study of the design and implementation of transaction processing systems and an introduction to basic communications concepts. A survey of commercially available software and a project using one of the systems is included. *Preq:* CP SC 462.

CP SC 672 Software Development Methodology 3(3,0) Advanced topics in software development methodology. Techniques such as chief programmer teams, structured design and structured walk-throughs are discussed and used in a major project. Emphasis is on the application of these techniques to large-scale software implementation projects. Additional topics such as mathematical foundations of structured programming and verification techniques are also included. *Preq:* CP SC 360 and 372.

CP SC 681 Selected Topics 1-3(1-3,0) Areas of computer science in which nonstandard problems arise. Innovative approaches to problem solutions which draw from a variety of support courses are developed and implemented. Emphasis is on independent study and projects. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* Consent of instructor.

CP SC 740 Computer Science for High School Teachers I 3(2,2) 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. *Preq:* Introductory computer programming.

CP SC 805 Advanced Computer Graphics 3(3,0) Advanced techniques used in the artificial rendering of natural scenes; current practice in computer graphics; full software implementation of each technique; extensive coding. *Preq:* Computer Graphics coursework or consent of instructor.

CP SC 807 3D Modeling and Animation 3(3,0) Foundation principles and practice of modeling, animating and rendering of 3D computer graphics scenes. Students complete a series of projects using industry-standard software. Topics include modeling techniques, technical animation, rigging, materials, lighting, scripting and post production. *Preq:* Digital Production Arts major or consent of instructor.

CP SC 808 Advanced Animation 3(3,0) Foundation principles of the production of computer animation, from original concept development and character design, through rigging of articulated figures, character animation methods, and digital cinematography. *Preq:* CP SC 807 or consent of instructor.

CP SC 809 Rendering and Shading 3(3,0) The art and science of lighting and shading for effective computer graphic imagery, including the mathematical, physical and perceptual elements contributing to the simulation of a desired visual look. Shading languages, advanced rendering tools, global illumination effects, production of photoreal and non-photoreal imagery. *Preq:* CP SC 807 or consent of instructor.

CP SC 810 Introduction to Artificial Intelligence 3(3,0) Problem solving and game playing; knowledge representation; expert systems; natural language processing; perception and learning. *Preq:* Consent of instructor.

CP SC 815 Special Effects Compositing 3(3,0) Video special effects, compositing problems, effects animation, matchmoving and 3-D geometry, color and texture reconstruction from 2-D images; extensive use of scripting languages and high-end software platforms. *Preq:* CP SC 605 or 807 or consent of instructor.

CP SC 819 Physically Based Visual Effects 3(3,0) Examines the use of physically based dynamic simulation techniques in the production of visual effects. Emphasizes tools, techniques and pipeline. Laboratory assignments are done using both commercial software and the student's custom code. *Preq:* CP SC 817 or consent of instructor.

CP SC 820 Parallel Architecture 3(3,0) Study of parallel processing issues including vector and pipeline processors, arrays of processing elements, associative processors, data flow computers, networks of processors. Also includes survey of parallel programming languages, design and implementation of parallel algorithms, and future trends. *Preq:* Computer Organization course or consent of instructor.

CP SC 822 Case Study in Operating Systems 3(2,2) Case study of the design of an operating system. Class periods are devoted to reviewing source code and deducing the structure of the system. Lab exercises require students to make major changes to the system to enhance its performance on particular workloads. *Preq:* Introduction to Operating Systems coursework or consent of instructor.

CP SC 824 Advanced Operating Systems 3(3,0) 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. *Preq:* Introduction to Operating Systems coursework or consent of instructor.

CP SC 827 Translation of Programming Languages 3(3,0) Theoretical foundations and algorithms for compiling and interpreting programming languages. Topics include lexical analysis, syntactic analysis, semantics analysis, optimization and code generation. Implementation of a compiler or a major component of a compiler is normally a term project. *Preq:* Introduction to Theory of Computer Science and Programming Systems coursework or consent of instructor.

CP SC 828 Theory of Programming Languages 3(3,0) Syntax and semantics of programming languages; finite state and pushdown processors; context-free models of syntax; parsing algorithms and semantic models. *Preq:* Introduction to Theory of Computer Science and Programming Systems coursework or consent of instructor.

CP SC 829 Advanced Compiler Topics 3(3,0) Code generation, register allocation, program optimization, data flow, interprocedural operations, parallel compilation and distributed compilation. *Preq:* CP SC 827 or consent of instructor.

CP SC 830 Systems Modeling 3(3,0) 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. *Preq:* MTHSC 600 or 800 or consent of instructor.

CP SC 838 Advanced Data Structures 3(3,0) 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. *Preq:* Consent of instructor.

CP SC 839 Foundations of Theoretical Computer Science 3(3,0) 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. *Preq:* Introduction to Theory of Computer Science coursework or consent of instructor.

CP SC 840 Design and Analysis of Algorithms 3(3,0) 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. *Preq:* Discrete Mathematics coursework or consent of instructor.

CP SC 845 Bioinformatics Algorithms 3(3,0) Covers algorithms such as dynamic programming for biological problems, including sequence alignment and phylogeny tree constructions; statistical and mathematical modeling of high throughput data, such as differentially expressed genes from microarray data and HMM for gene prediction; graph and network theory for biological networks.

CP SC 851 Software Systems for Data Communications 3(3,0) 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. *Prq:* Consent of instructor.

CP SC 852 Internetworking 3(3,0) 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. *Prq:* CP SC 851, E C E 638, or consent of instructor.

CP SC 853 Implementation of TCP/IP Protocols 3(3,0) Case study of the architecture of a widely-used implementation of the TCP/IP protocol stack. Source code reviews illustrate layered design and use of core kernel services. Student projects include implementation of a complete IP transport protocol. *Prq:* CP SC 822 and 852, or consent of instructor.

CP SC 854 Performance Analysis of Internet Protocols 3(3,0) Analyzes network performance, focusing on experimental methods and current Internet protocols. Covers random processes, time series analysis and simulation concepts. Incorporates experimental-based research in computer networking. *Prq:* CP SC 852 or consent of instructor.

CP SC 855 Embedded Network Systems 3(3,0) Discusses hardware fundamentals, technology applications, operating systems, programming platforms, software design and implementation, energy conservation techniques, self-stabilization paradigm, routing algorithms, clustering algorithms, time synchronization algorithms and sensor-actuator integration. *Prq:* Consent of instructor.

CP SC 862 Database Management System Design 3(3,0) 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. *Prq:* Introduction to Database coursework or consent of instructor.

CP SC 863 Multimedia Systems and Applications 3(3,0) Principles of multimedia systems and applications; techniques in effectively representing, processing and retrieving multimedia data such as sound and music, graphics, image and video; operating system and network issues in supporting multimedia; advanced topics in current multimedia research. Term project requires implementing some selected components of a multimedia system. *Prq:* Consent of instructor.

CP SC 865 Data Mining 3(3,0) Study of principles of data mining: concepts and techniques of data analysis including regression, clustering, classification, association, prediction, etc.; efficient data mining algorithms; data mining applications in various areas including market analysis and management, WWW mining, bioinformatics, etc. Course projects for designing and using data mining algorithms in the applications are required. *Prq:* Knowledge of statistics and database systems or consent of instructor.

CP SC 870 Software Design 3(3,0) Fundamental concepts of object modeling using object-oriented analysis and design; realistic application of software engineering principles within a variety of problem domains; mainstream language with facilities for object-training programming. *Prq:* Proficiency in programming in a procedural language.

CP SC 871 Foundations of Software Engineering 3(3,0) Techniques and issues in software design and development; tools, methodologies and environments for effective design, development and testing of software; organizing and managing the development of software projects. *Prq:* Graduate standing in Computer Science or consent of instructor.

CP SC 872 Software Specification and Design Techniques 3(3,0) Techniques, tools, environments and formal methods for software specification and design; verification of design correctness. *Prq:* Introduction to Software Engineering coursework or consent of instructor.

CP SC 873 Software Verification, Validation and Measurement 3(3,0) 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. *Prq:* Introduction to Software Engineering coursework or consent of instructor.

CP SC 875 Software Architecture 3(3,0) Creation, analysis and maintenance of architectures for software systems. Basic principles, patterns and techniques. Quality attributes of the architecture are used to make a quantitative analysis. Students create and analyze two architectures from different domains.

CP SC 877 Fundamentals of Biometric Systems 3(3,0) Methods and principles for the automatic identification/authentication of individuals. Technologies include fingerprint, face, iris and hand geometry. Additional topics include biometric system design, performance evaluation, multi-modal biometrics and ethics/privacy issues. *Prq:* Consent of instructor.

CP SC 881 Selected Topics 1-3(1-3,0) Advanced topics from current problems of interest in computer science. Topics vary from semester to semester. May be repeated for credit, but only if different topics are covered. *Prq:* Consent of instructor.

CP SC 888 Directed Projects in Computer Science 1-6 Directed individual project supervised by department faculty. To be taken Pass/Fail only.

CP SC 891 Master's Thesis Research 1-12

CP SC 940 Topics in Advanced Algorithms 3(3,0) Study of selected topics in advanced algorithms drawn from graph algorithms (network flows, matchings, cuts, planarity testing), approximation algorithms (traveling salesman, linear relaxation techniques), distributed algorithms (mutual exclusion, synchronization, self-stabilization), parallel algorithms (parallel prefix, models, sorting), or randomized algorithms (sampling, probabilistic methods, random walks). May be repeated for a maximum of nine credits, but only if different topics are covered. *Prq:* CP SC 840 or consent of instructor.

CP SC 950 Selected Topics in Computer Science 1-3(1-3,0) Study of advanced topics from current problems of interest in computer science. May be repeated for a maximum of 12 credits, but only if different topics are covered. To be taken Pass/Fail only.

CP SC 951 Seminar in Algorithms 1-3(1-3,0) Advanced topics from current problems of interest in algorithms. May be repeated for credit.

CP SC 955 Seminar in Programming Languages 1-3(1-3,0) Advanced topics from current problems of interest in programming languages. May be repeated for credit.

CP SC 957 Seminar in Software Engineering 1-3(1-3,0) Advanced topics from current problems of interest in software engineering. May be repeated for credit.

CP SC 981 Seminar in Computer Science 1-3(1-3,0) Topics of current research interest. May be repeated for credit.

CP SC 991 Doctoral Dissertation Research 1-12

CONSTRUCTION SCIENCE AND MANAGEMENT

C S M 655 Reducing Adversarial Relations in Construction 3(3,0) Focuses 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. *Prq:* Construction Science and Management or Architecture major, senior standing, or consent of department chair.

C S M 852 Construction Management Research 3(3,0) Research methodology applied to the construction industry. *Prq:* Consent of instructor.

C S M 860 Construction Financial Planning and Analysis 3(3,0) Theory of financial management as it relates to the financial challenges faced by the construction firm. *Prq:* Consent of instructor.

C S M 861 Construction Control Systems 3(3,0) Development and analysis of cost, resource and quality control programs for a company's construction projects. *Prq:* Consent of instructor.

C S M 862 Personnel Management and Negotiations 3(3,0) The role of management and unions in the construction industry. Topics include contract negotiation, collective bargaining, dispute resolution and management for productivity improvement. *Prq:* Consent of instructor.

C S M 863 Advanced Planning and Scheduling 3(3,0) Analysis and control of construction projects using advanced techniques for planning, scheduling and resources control. *Preq:* Consent of instructor.

C S M 864 Construction Business Strategy and Marketing 3(3,0) Techniques for business strategy development and marketing of various types of construction companies. *Preq:* Consent of instructor.

C S M 865 Project Management 3(3,0) Theory of project administration and control with special emphasis on the role and responsibilities of the project manager. *Preq:* Consent of instructor.

C S M 866 Contractor Role in Development 3(3,0) Addresses the various roles and responsibilities of the contractor in development including discussion of the owner/designer/constructor relationship. Does not count toward Master's in Construction Science and Management degree requirements. *Preq:* Consent of instructor.

C S M 881 Professional Seminar 3(3,0) New and emerging methods for management of the construction or construction-related firm. *Preq:* Consent of instructor.

C S M 889 Special Problems 3(3,0) Research design problem on a construction-related topic. *Preq:* C S M 852 or consent of department chair.

C S M 890 Directed Studies 3-6 Special topics not covered in other courses. Emphasis is on field studies, research activities and current developments in building science. *Preq:* Consent of instructor.

C S M 891 Master's Thesis Research 1-9 With approval of the advisory committee, students carry out independent research and analysis. Thesis is presented orally and in writing and in strict compliance with the guidelines of the Graduate School.

CROP AND SOIL ENVIRONMENTAL SCIENCES

CSENV 603 Soil Genesis and Classification 2(1,3) Soil morphology and characterization, pedogenic processes, soil-forming factors and classification of soils. Offered fall semester only. *Preq:* CSENV 202 or consent of instructor.

CSENV 605 Plant Breeding 3(2,2) Application of genetic principles to the development of improved crop plants. Principle topics include 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. Offered spring semester only. *Preq:* GEN 302 or equivalent.

CSENV (B E) 608 Land Treatment of Wastewater and Sludges 3(3,0) Principles for designing environmentally acceptable land application systems using municipal and industrial wastewater and sludges are presented. Topics include 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. *Preq:* Senior standing in agriculture or engineering or consent of instructor.

CSENV 609 Biology of Invasive Plants 3(3,0) Introductory course covers mechanisms of plant invasions. Emphasizes unique traits that confer invasiveness and/or weediness to plants and how these plant traits interact with the environment to facilitate invasion of agricultural lands, forests, rangelands and less-managed landscapes. Covers various cultural, chemical and biological control aspects. *Preq:* BIOL 104/106, or BIOSC 304, or consent of instructor.

CSENV 621 Principles of Field Crop Production 3(3,0) Principles for production of field crops. Topics include botany and physiology, tillage, harvesting, storage and crop quality. Principles are illustrated using examples from various crops. Offered fall semester only. *Preq:* AGRIC 104 or equivalent introductory plant science, CSENV 202.

CSENV 622 Major World Crops 3(3,0) Examines the distribution, adaptation, production and utilization of major agronomic crops of the world. Emphasizes crops important to U.S. agriculture. Specific crops discussed in more detail include corn, wheat, rice, sorghum, soybean, cotton, tobacco and peanuts. Offered spring semester only. *Preq:* AGRIC 104 or equivalent introductory plant science, CSENV 202.

CSENV 623 Field Crops—Forages 3(3,0) Establishment, management and utilization of forage crops in a forage-livestock agro-ecosystem context. Hay, silage and pasture utilization are discussed. Computer model is used to study complexity of forage-livestock production systems. *Preq:* AGRIC 104, CSENV 202, or consent of instructor.

CSENV (AP EC) 626 Cropping Systems Analysis 3(2,2) Application of agronomic and economic principles in solving problems relating to the production and marketing of agronomic crops. Major part of the course is a case study in which detailed analysis of a farm, agribusiness, or environmental situation is made with students making formal written and oral presentations of results. Offered fall semester only. *Preq:* AGRIC 104, AP EC 202, Junior standing.

CSENV (HORT) 633 Landscape and Turf Weed Management 3(2,2) See HORT 633.

CSENV 646 Soil Management 3(3,0) Basic soil properties are related to compaction, water and solute movement and root growth. Practical management problems are considered and solutions developed based on basic soil characteristics. Problems include erosion, no-tillage, compaction, irrigation, leaching, waste application, golf-green management and orchard establishment. Offered fall semester only. *Preq:* CSENV 202.

CSENV 652 Soil Fertility and Management 3(3,0) 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. Offered spring semester only. *Preq:* CSENV 202 or consent of instructor.

CSENV 653 Soil Fertility Laboratory 1(0,3) Evaluation and interpretation of soil fertility production. Offered spring semester only. *Preq:* CSENV 202 or consent of instructor.

CSENV (ENTOX, GEOL) 685 Environmental Soil Chemistry 3(3,0) Study of soil chemical processes (sorption, desorption, ion exchange, precipitation, dissolution and redox reactions) of nutrients and inorganic and organic contaminants in soils and organic matter. Chemical complex equilibria and adsorption phenomena at the solid (soil, sediment and mineral) water interface are emphasized. *Preq:* CSENV 202, CH 102 or consent of instructor.

CSENV 690 Beneficial Soil Organisms in Plant Growth 3(3,0) Aspects of biological nitrogen fixation, mycorrhizal fungi, microbial-pesticide interactions, bioremediation, nutrient cycles and biological pest control related to plant growth, soil/environmental quality and sustainable agriculture. Students who desire laboratory experience in these topics may register for CSENV 406 after consultation with instructor. Offered spring semester only. *Preq:* CSENV 202, MICRO 305, PL PA 401, or consent of instructor.

CSENV 701 Soils and Man 3(3,0) Different kinds of soils, their properties, uses, management, conservation and relationship with the environment and other human endeavors.

CSENV 801 Crop Physiology and Nutrition 3(3,0) Basic concepts and physiologic aspects of growth and culture applied to crop management practices. Offered fall semester of odd-numbered years only. *Preq:* BIOSC 401, 402; or equivalent.

CSENV 802 Pedology 3(3,0) Current concepts and theories in soil genesis and morphology; advanced study of soil taxonomy. Offered fall semester of odd-numbered years only. *Preq:* CSENV 403.

CSENV 804 Theory and Methods of Plant Breeding 3(3,0) Concepts and principles of plant breeding and genetics as applied to development and maintenance of improved crop varieties; theoretical considerations of various breeding methods. Offered fall semester of even-numbered years only. *Preq:* CSENV 405, EX ST 801, or consent of instructor.

CSENV 805 Soil Fertility 3(3,0) 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. Offered spring semester of even-numbered years only. *Preq:* CSENV 403 or 452 or consent of instructor.

CSENV 806 Special Problems 1-3(0,3-9) Research not related to a thesis.

CSENV 807 Soil Physics 4(3,3) Principles and applications of transport of water and solutes in soils emphasizing unsaturated flow phenomenon. Offered fall semester of even-numbered years only. *Preq:* MTHSC 108 or equivalent.

CSENV 808 Soil Chemistry 3(2,3) 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. Offered fall semester of odd-numbered years only.

CSENV 810 Soil Microbiology 3(3,0) Biological nitrogen fixation, mycorrhizal fungi and pesticide interactions in soils with emphasis on microbial-plant-soil relationships. Offered fall semester of even-numbered years only. *Preq:* CSENV 690 or MICRO 610 and consent of instructor.

CSENV 812 Crop Ecology and Land Use 3(3,0)
 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. Offered fall semester of even-numbered years only.

CSENV (BOT) 824 Mode of Action of Growth Substances 4(3,3) Study of the physiology and biochemistry of both natural and synthetic growth regulators, hormones, growth retardants, herbicides and other inhibitors. Considers methodology and mechanism of action. Offered spring semester of odd-numbered years only. *Prerequisite:* BIOSC 601 and 602 and general biochemistry or BOT 822 or consent of instructor.

CSENV (PES) 850 Agricultural Biotechnology 2(2,0) Fundamentals of biotechnology for students specializing in applied life sciences. Scientific principles, limitations, novel concepts and wide-ranging applications of biotechnology to agricultural industry.

CSENV 890 Special Topics in Agronomy 1-3(1-3,0) Group discussion of recent developments in agronomic research. May be repeated for a maximum of six credits. *Prerequisite:* Consent of instructor.

DIGITAL PRODUCTION ARTS

D PA 600 Technical Foundations of Digital Production I 3(3,0) The technical, conceptual, and algorithmic foundations of computer graphics. Covers the Unix operating system, scripting, C programming, and an interactive graphics API. *Prerequisite:* Consent of instructor. Not open to Computer Science, Computer Engineering, or Computer Information Systems majors.

D PA 601 Technical Foundations of Digital Production II 3(3,0) The mathematical and algorithmic foundations of computer graphics. Covers spatial data structures, object oriented programming in C++, mathematics for graphics, and 3-D graphics API. *Prerequisite:* D PA 400 or consent of instructor. Not open to Computer Science, Computer Engineering, or Computer Information Systems majors.

D PA 602 Visual Foundations of Digital Production I 3(0,6) Presents the visual foundations underlying computer graphics production. Covers perspective, observational drawing, color and value, principles of composition and design, and storyboarding. Incorporates the studio method, involves students in hands-on work and the critique process, and stresses examples from the history of art, animation and film. *Prerequisite:* Consent of instructor. Not open to Architecture or Visual Arts majors.

D PA 603 Visual Foundations of Digital Production II 3(0,6) Extends the foundational visual principles underlying computer graphics production begun in D PA 402. Stresses representation of the figure in drawing and the use of cameras. Incorporates the studio method and the critique process, and stresses examples from the history of art, animation and film. *Prerequisite:* D PA 402 or consent of instructor. Not open to Architecture or Visual Arts majors.

D PA 860 Digital Production Studio 1-6(0,2-12) Students develop as accomplished visual problem solvers in a digital production team setting. As part of the studio experience, students take a production project from concept, through story development, character design, modeling and rigging, animation, lighting, and post production. May be repeated for a maximum of 12 credits. *Prerequisite:* Enrollment in the Digital Production Arts program.

D PA 880 Graduate Research Studio 1-6(0,2-12) Students complete a project or projects, under the direction of a faculty adviser, in an area supporting personal goals and vision. Work may be individually or team oriented, and may be of a technical or an artistic nature. May be repeated for a maximum of six credits. *Prerequisite:* Enrollment in the Digital Production Arts program.

D PA 891 Master of Fine Arts Thesis Research 1-6 Students complete a studio research project, under the guidance of the student's advisor and thesis committee. The thesis project is developed to a refined degree, articulated in the form of a written document, and presented orally in a thesis defense. May be repeated for a maximum of six credits. *Prerequisite:* Consent of thesis committee chair.

EARLY CHILDHOOD EDUCATION

ED EC 800 Parent Education in Early Childhood Multicultural Settings 3(3,0) Focuses on a multicultural perspective on parent involvement in early childhood education settings. Theory and applications of parent involvement in multicultural environments are studied with an emphasis on activities that set the stage for science and math concept development and on uses of technology with young children.

ED EC 810 Advanced Early Childhood Education Foundations and Methods 3(3,0) In-depth study of developmentally appropriate and effective instructional methods in early childhood classrooms and the history of early childhood education as a professional field.

ED EC 820 Advanced Early Childhood Education Curriculum 3(3,0) In-depth study of curriculum development and current approaches in the field of early childhood education. Students explore the research literature on effective curriculum in early childhood education at both the national and international levels. *Prerequisite:* Consent of instructor.

ED EC 840 Theories of Early Childhood Education 3(3,0) Examines the theoretical, philosophical and research foundations of early childhood education with emphasis on how these foundations interact with science, math and technology concept development in young children. Students develop skills in critical inquiry as they explore specific topics related to early child care and education.

ED EC 850 Creative and Cognitive Development in Early Childhood: Creating Connections to Math and Science 3(3,0) Examines the theoretical, philosophical and cognitive foundations of creative thought during the early childhood years. Students develop skills in critical inquiry as they explore the connections between creativity and math/science education during the early childhood years.

ED EC 880 Current Issues in Early Childhood 3(3,0) Focuses on factors that impact early childhood policy, identification of current problems/issues and development of research-based advocacy strategies.

ED EC 885 Thesis Hours in Early Childhood Education 3(3,0) Students work with thesis advisor and committee to complete thesis requirements; thesis must address a STEM discipline. Required of students enrolled in thesis track in Early Childhood Education. May be repeated for a maximum of six credits. *Prerequisite:* 18 credit hours including ED F 778, 879; consent of thesis advisor.

ED EC 890 Assessment and Program Planning in Early Childhood 3(3,0) Study of instructional planning and assessment for young children in all content areas including math, science and technology. Also explores multiple assessment and screening strategies for infants, toddlers and preschool children with typical and atypical development; includes quantitative and qualitative assessment methods for program planning.

ED EC 895 Math, Science and Technology Inquiry in Early Childhood 3(3,0) Emphasizes theory to practice and exploration of the processes of inquiry in mathematics, science and technology for early childhood education.

ED EC 896 Early Childhood Math and Science Curricula 3(3,0) Provides a vertical articulation of math and science curricula for the early childhood years through an in-depth analysis of national standards for content and pedagogy. Students experience the progression of math and science understanding in the early years.

ECONOMICS

ECON 605 Introduction to Econometrics 4(3,3) Introduction to the methods of quantitative analysis of economic data. Reviews basic statistical methods and probability distribution. Topics include data management using professional statistical software applications; multiple regression analysis; hypothesis testing under conditions of multicollinearity, heteroscedasticity; and serial correlation. *Prerequisite:* ECON 211 and 212; MTHSC 108 or 207; EX ST 301 or MTHSC 301 or 309.

ECON 606 Advanced Econometrics 3(3,0) Reviews statistical inference using multiple regression (OLS) analysis and model specification. Topics include multicollinearity; heteroscedasticity and serial correlation; two-stage least squares and instrumental variables models; simultaneous equations models; limited dependent variable models using maximum likelihood estimation and time-series analysis; and presentation of results in technical writing. *Prerequisite:* ECON 405 or consent of instructor.

ECON 610 Economic Development 3(3,0) Consideration and analysis of economic and related problems of underdeveloped countries. Attention is given to national and international programs designed to accelerate solution of these problems. *Prerequisite:* ECON 314 or consent of instructor.

ECON 611 Economics of Education 3(3,0) Analysis of economic issues related to education. The decision to invest in education, elementary and secondary school markets and reform, the market for college education, teacher labor markets and education's effects on economic growth and income distribution. *Prerequisite:* ECON 314 or consent of instructor.

ECON 612 International Microeconomics 3(3,0) Analysis of the essential aspects of international economic linkages. Discusses gains and redistributive effects of trade and the barriers to trade within the context of a variety of economic models. Also discusses the history of trade policy and the political economy of its determination. *Prerequisite:* ECON 314 or consent of instructor.

ECON 613 International Macroeconomics 3(3,0) Examination of macroeconomic linkages between an individual country and the rest of the world and how these linkages are affected by the choice of exchange rate regimes. Topics include the relation between domestic and foreign interest rates and exchange rates and the ability to pursue independent monetary policies. *Prerequisite:* ECON 315.

ECON 622 Monetary Economics 3(3,0) Intensive study of the role of monetary factors in economic change. Modern monetary theories and their empirical relevance for policy are developed against a background of monetary history and institutions. *Prerequisite:* ECON 314 and 315 or consent of instructor.

ECON 623 Economics of Health 3(3,0) Applies microeconomic theory to examine the demand for health services and medical care, the market for medical insurance, the behavior of physicians and hospitals, and the role of government in health-care provision and regulation. *Prerequisite:* ECON 314.

ECON 624 Organization of Industries 3(3,0) Empirical, historical, and theoretical analyses of market structure and concentration in American industry: the effects of oligopoly, monopoly, and cartelization upon price, output, and other policies of the firm; antitrust and other public policies and problems are studied. *Prerequisite:* ECON 314 or consent of instructor.

ECON 625 Antitrust Economics 3(3,0) Analysis of economic and legal issues created by the exercise of market power. The motivation and execution of government policy toward mergers, predatory conduct and various restraints of trade are extensively examined. *Prerequisite:* ECON 309 or 314 or consent of instructor.

ECON 626 Seminar in Sports Economics 3(3,0) Economic analysis of sports teams, leagues and institutions. Topics include antitrust issues, public funding of sports venues, labor relations, wagering markets, athlete compensation and application of economic principles to sports settings. Empirical research project is cornerstone of course. *Prerequisite:* ECON 314 and 405 or consent of instructor.

ECON 627 Development of the American Economy 3(3,0) Explores several topics relevant to understanding the American experience. Considers the institutions and developments critical to America's ascendancy from a small country to a dominant global economic power. Investigates immigration, innovation, education, finance and the changing role of race and gender in the economy. *Prerequisite:* ECON 314, 315.

ECON 628 Cost-Benefit Analysis 3(3,0) Develops techniques for the appraisal of public expenditure programs with particular emphasis on investment in infrastructure. Topics include the choice of an appropriate discount rate and the calculation of social costs and benefits in the presence of market distortions. *Prerequisite:* ECON 314 or consent of instructor.

ECON 630 Topics in Mathematical Economics 3(3,0) Skills acquired in freshman mathematics are applied to selected topics in economic theory. Course is a good complement to ECON 314 and provides excellent preparation for 400-level courses in economics, especially ECON 405. May be taken concurrently with ECON 314. *Prerequisite:* ECON 314, and MTHSC 108 or 207.

ECON 640 Game Theory 3(3,0) Introduction to the formal analysis of strategic interaction among rational, self-interested rivals. Basic theoretical aspects of games are discussed and applied to such topics as bargaining, voting, auctions and oligopoly. *Prerequisite:* ECON 314 and MTHSC 106, or ECON 430, or consent of instructor.

ECON 655 Applied Microeconomic Research 3(3,0) Students conduct research in applied microeconomics. Topics vary according to student and professor interests. Students read papers in the literature, formulate their own economic hypotheses and collect and analyze data to test those hypotheses. May be repeated for a maximum of nine credits. *Prerequisite:* ECON 314 or consent of instructor.

ECON (AP EC) 657 Natural Resource Use, Technology and Policy 3(3,0) See AP EC 657.

ECON 751 Selected Topics for Teachers 3(3,0) 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 repeated for credit. *Prerequisite:* ECON 200, 211.

ECON (AP EC) 800 History of Economic Thought 3(3,0) 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 (AP EC) 801 Microeconomic Theory 3(3,0) Microeconomic theory and its use to analyze and predict the behavior of industries, firms and consumers under various market conditions. Offered fall semester only.

ECON (AP EC) 802 Advanced Economic Concepts and Applications 3(3,0) Rigorous development of price theory under alternative product and resource market structures. *Prerequisite:* Consent of instructor.

ECON (AP EC) 804 Applied Mathematical Economics 3(3,0) See AP EC 804.

ECON 805 Macroeconomic Theory 3(3,0) Macroeconomic theory involving static and dynamic models and their use in analysis of economic problems and policies.

ECON (AP EC) 806 Econometrics I 3(3,0) See AP EC 806.

ECON 807 Econometrics II 3(3,0) 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. Offered fall semester only.

ECON (AP EC) 808 Econometrics III 3(3,0) Continuation of ECON 807. Covers current economic models and estimation procedures. Offered spring semester only. *Prerequisite:* ECON 807.

ECON (AP EC) 809 Advanced Natural Resource Economics 3(3,0) See AP EC 809.

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

ECON (AP EC) 811 Economics of Environmental Quality 3(3,0) 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. Offered fall semester of even-numbered years only. *Prerequisite:* ECON 314 or equivalent.

ECON 815 Economic History of the United States 3(3,0) Introduces approach of modern economic history, which emphasizes the use of modern economic theory and statistical methods to answer questions of long-standing interest to economists and historians. Covers all major periods of U.S. history from the colonial era through the emergence of the modern welfare state. *Prerequisite:* ECON 801 and 805; ECON 806 highly recommended.

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

ECON (AP EC) 817 Advanced Production Economics 3(3,0) See AP EC 817.

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

ECON 821 Public Choice 3(3,0) 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 (AP EC) 822 Public Policy Economics 3(3,0) See AP EC 822.

ECON 823 Microeconomics for Public Policy 3(3,0) Economic aspects of public policy making; individual behavior as governed by the market and other incentive mechanisms. Equips students with methodological tools for evaluating public policies. *Prerequisite:* Admission to the Policy Studies program or consent of instructor.

ECON (AP EC) 824 Organization of Industry 3(3,0) 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 825 Antitrust Economics 3(3,0) Theoretical analysis of monopoly, monopolizing practices and the exercise of market power. Study of government policy towards mergers, predation and restraints of trade. *Prerequisite:* ECON (AP EC) 801.

ECON (AP EC) 826 Economic Theory of Government Regulation 3(3,0) 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 (AP EC) 827 Economics of Property Rights 3(3,0) Analyzes the evolution and impact of various property rights institutions on individual behavior and the subsequent use of resources. Particular attention is paid to the importance of property rights structures in the organization of business and in managerial decision making. *Preq:* ECON 801.

ECON (AP EC) 828 Applied Demand Analysis 3(3,0) See AP EC 828.

ECON (AP EC) 831 Economic Development 3(3,0)

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 (AP EC) 832 Community and Regional Economics 3(3,0) See AP EC 832.

ECON 836 Research in Economics of Education 3(3,0)

Theoretical and econometric analysis of education including such topics as human capital theory, pricing and competition in higher education, public financing and provision of education, cost/benefit analyses of education reforms such as accountability, school finance equalization and school choice. Includes discussion and research on current topics in the economics of education. *Preq:* AP EC (ECON) 806 or consent of instructor.

ECON (AP EC) 840 International Trade Theory 3(3,0)

Theory of free trade from Ricardo to the present; theory and application of optimal and second-best tariffs; recent empirical testing of trade and tariff theory. *Preq:* ECON 314 and (AP EC) 802 or consent of instructor.

ECON (AP EC) 841 International Finance 3(3,0)

Financial economics of decision making in a multinational environment featuring autonomous governments and multiple currencies. Typical topics include the macroeconomic problems of unemployment and inflation in an international economy, management of exchange rate risk, credit risk, political risk and taxation. *Preq:* ECON 315 or equivalent.

ECON 845 Advanced Game Theory 3(3,0)

Introduces central concepts in game theory, emphasizing economic problems involving strategic behavior by consumers, firms and governments. Covers static and dynamic games, with both complete and incomplete information. Specific topics may include oligopoly, bargaining, auction theory, mechanism design, repeated games and information transmission.

ECON (AP EC) 855 Financial Economics 3(3,0)

Study of modern theory of corporate finance. Includes basic theories of efficient markets, portfolio selection, capital asset pricing, option pricing and agency costs. *Preq:* ECON (AP EC) 801 or consent of instructor.

ECON 888 Directed Reading in Economics 1-3(1-3,0)

Directed reading and research in the student's field of interest. May be repeated for a maximum of three credit.

ECON 891 Master's Thesis Research 1-12

ECON 900 Selected Topics in Economics 3(3,0) Current topics in economic theory and empirical research. May be repeated for credit, but only if different topics are covered.

ECON (AP EC) 901 Price Theory 3(3,0) 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. *Preq:* ECON (AP EC) 801 or equivalent.

ECON (AP EC) 904 Seminar in Resource Economics 3(3,0) See AP EC 904

ECON 905 Advanced Macroeconomic Issues 3(3,0)

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. *Preq:* ECON 805 or equivalent.

ECON (AP EC) 906 Seminar in Area Economic Development 3(3,0) See AP EC 906.

ECON 909 Time-Series Econometrics 3(3,0)

Introduces methods and models of time-series analysis. Reviews statistical concepts and introduces unique aspects of time-series data. Covers models useful for estimation, forecasting and inference in macroeconomics and finance. Topics include autoregressive-moving average models, their multivariate generalization, nonlinear models of conditional heteroskedasticity, regime-switching models and nonstationary processes. *Preq:* ECON 807.

ECON 915 General Equilibrium and Economic Growth 3(3,0)

Risk sharing and efficient allocations are presented. Basic aggregation theory is covered producing the representative agent model. The neoclassical growth model with and without technological progress is presented, followed by the endogenous growth model. The modifications to this model produce multiple development regimes, convergence, biconvergence and switching phenomena. *Preq:* ECON 805

ECON 916 Advanced Economic Growth 3(3,0)

Alternative models of endogenous growth are developed, including the public education models of growth, endogenous technology-R&D models, international trade and diffusion models, public policies and institutions, geography and growth, and finance and growth. Particular focus is on the empirical applications of growth models. *Preq:* ECON 915.

ECON (AP EC) 917 Advanced Seminar in Labor Economics 3(3,0)

Continuation of ECON 816, bridging the gap between theory and modern empirical research in labor economics. Emphasizes reading recent empirical research papers to understand the techniques of modern research in labor economics. *Preq:* ECON (AP EC) 816.

ECON 920 Empirical Public Economics 3(3,0)

Studies the effects of taxation on household and firm behavior, public goods, income transfer and welfare policies. Considers fiscal federalism, public policy and economic growth. Includes selected topics on effects of legislation and institutions on economic outcome. *Preq:* ECON (AP EC) 801, (AP EC) 820.

ECON 924 Advanced Industrial Organizations 3(3,0)

Coverage of advanced concepts and methods involving strategic interaction among firms. Topics may include pricing, capacity choice, advertising, collusion and industry dynamics. *Preq:* ECON (AP EC) 824 or consent of instructor.

ECON 940 Empirical International Economics 3(3,0)

Investigates empirical applications of international issues. Typical topics include the theoretical and empirical international issues, including the Heckscher-Ohlin model, the gravity model of trade, models of exchange rate determination and dynamic stochastic general equilibrium models. *Preq:* ECON 840 or 841.

ECON (AP EC) 950 Monetary Economics 3(3,0)

Economic analysis of money in our economy and effects of monetary policy on prices, interest rates, output and employment.

ECON 981 Applications of Economic Analysis 1-2(1-2,0)

Presentations of economic research by guest lecturers, principally department faculty members. Presentations include description of one or more research projects typically taken from a common agenda. Discussion of methodology, data and data collection. Course is for first-year PhD students. To be taken Pass/Fail only. May be repeated for a maximum of four credits.

ECON 982 Workshop in Applied Economics 3(3,0)

Forum for presentation and critical evaluation of ongoing research by candidates for the PhD degree in Applied Economics. May be repeated for a maximum of nine credits. *Preq:* Consent of instructor.

ECON (AP EC) 991 Doctoral Dissertation Research 1-12 See AP EC 991.

EDUCATION

ED 641 Middle School Curriculum 3(3,0)

Concepts and methods for teaching middle school students. Discusses nature of middle school students, teacher characteristics, curricular and co-curricular programs, organization and teaching.

ED (CTE) 700 Supervising the Student Teacher in the Public School 2-3(2-3,0)

Knowledge and skills desirable for supervisors of student teachers; use of observation instruments for recording objective data and evaluating teaching performance. To be taken Pass/Fail only. *Preq:* Professional teaching certificate, at least one year of teaching experience, recommendation from employing school district, or consent of instructor.

ED 735 Teacher Professional Development: Selected Topics 1-3(1-3,0)

Selected topics determined by professional-development needs for teachers. Does not count toward a master's degree; for professional development credit only. May be repeated, but only if different topics are covered.

ED 837 Independent Study in Education 1-3(1-3,0)

Master's-level study of selected topics under the direction of a faculty member chosen by the student. Student and faculty member develop a course of study different from any existing courses and designed for the individual student. May be repeated for a maximum of 24 credits, but only if different topics are covered.

ED 838 Selected Topics in Education 1-3(1-3,0)

Specific master's-level topics not found in other courses are selected for in-depth study. May be repeated for a maximum of 24 credits, but only if different topics are covered.

ED 839 Introduction to Linguistics 3(3,0)

Introduction to linguistics, including the subfields of syntax, morphology, phonology, semantics, pragmatics and sociolinguistics. Also includes the study of writing systems and applications to literacy, language acquisition, and language contact and change.
Preq: Graduate standing in Education or consent of instructor.

ED 845 Integrating Arts into the Curriculum 3(3,0)

Series of workshops introducing the integration of drama, music, dance, visual arts and creative writing with academic subjects in the classroom. Includes review of research on the impact of arts education on student achievement, engagement and school culture.

ED 851 International Education in Primary and Secondary School Settings 3(3,0)

Investigates educational processes in international settings, including an examination of prevalent learning theories, curricula, assessment, classroom norms, and their connections to social, cultural, and geopolitical contexts.

ED 854 International Perspectives on Poverty and the Schools 3(3,0)

Explores the global impact of poverty on schools and students, reviews the international research on poverty and schools, identifies effective instructional and curricular strategies for P-12 students living in poverty, and analyzes international policies that address the needs of these students.

ED 860 Classroom Action Research 3(3,0)

Develops skills for doing research in a K-12 setting on instructional methodology and/or curriculum. Study of research literature, research methods and IRB procedures. Includes classroom action research project. *Preq:* Teaching certification, admission to MEd degree program, ED F 778, 808, or consent of instructor.

ED 867 Practicum in the Instruction of English to Speakers of Other Languages to Elementary and Secondary Learners 1-3(0,3-9)

Supervised observation and teaching experiences in teaching English to Speakers of Other Languages (ESOL) in cooperation with selected elementary and/or secondary schools. May be repeated for a maximum of three credits

ED (AG ED, CTE) 889 Research in Education 3(3,0)

See AG ED 889.

ED 901 Selected Topics Doctoral Study 1-3(1-3,0)

Doctoral-level education topics not covered in other courses are selected for in-depth study and research. May be repeated for a maximum of 24 credits, but only if different topics are covered.

ED 902 Independent Doctoral Study 1-3(1-3,0)

Study of selected topics in education under the direction of a faculty member chosen by the student. Student and faculty member develop a course of study different from any existing courses and designed for the individual student. May be repeated for a maximum of 24 credits, but only if different topics are covered.

ED 903 Introductory Doctoral Seminar I 1(1,0)

Familiarizes new doctoral students with the academic culture of doctoral studies and, specifically, the Curriculum and Instruction doctoral program at Clemson. This introductory seminar emphasizes the processes of scholarship, including academic research and writing.

ED 904 Introductory Doctoral Seminar II 1(1,0)

Familiarizes new doctoral students with the academic culture of doctoral studies and, specifically, the Curriculum and Instruction doctoral program at Clemson. This introductory seminar emphasizes the roles and responsibilities of teacher educators.

ED 938 Grant Development in Education-Related Fields 3(3,0)

Addresses the process for writing and submitting grant proposals, including training grants, demonstration projects, research grants and curriculum development projects.

ED 942 Studies of Curriculum and Instruction in Mathematics Education 3(3,0)

Addresses philosophical, theoretical, and empirical issues related to curriculum, instruction, and assessment in mathematics education. Curricular issues relevant to this class span pre-K through grade 12 and include the emergence of national, state, and common core standards. *Preq:* Admission into the Curriculum and Instruction doctoral program; consent of instructor.

ED 947 Current Scholarship in Mathematics Education 3(3,0)

Enhances appreciation for and understanding of research methods and findings in mathematics education. Includes an analysis of research methodology and techniques in mathematics education, the history of research in mathematics education, and various theories of mathematics learning. *Preq:* Admission into the Curriculum and Instruction doctoral program; consent of instructor.

ED 954 Curriculum Theory 3(3,0)

Main currents of curriculum theory in American education. *Preq:* ED EL 760.

ED 955 Theoretical Bases of Instruction 3(3,0)

Seminar in the application of learning theory to instructional practice emphasizing instructional strategies in the classroom.

ED (ED F, ED SP) 980 Internship in Curriculum and Instruction 1-6(0,3-18)

Practical experiences linking the student's program of study to his/her field of professional service. To be taken Pass/Fail only. *Preq:* Consent of advisor.

ED (ED F, ED SP) 991 Doctoral Dissertation Research 1-18

ED (ED F, ED SP) 994 Directed Research 1-4(1-4,0)

Research in a line of inquiry in education under the direction of faculty. May be taken with different faculty members and may be repeated for a maximum of 18 hours. To be taken Pass/Fail only. *Preq:* ED F 778, 808 or consent of instructor.

EDUCATIONAL COUNSELING (Counselor Education)

ED C 764 Theoretical and Practical Application of Student Development and Leadership in a University Setting 3(3,0)

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 School Counseling 3(3,0)

Theory and practice of school counseling; principles and policies underlying programs. *Preq:* Consent of instructor.

ED C 803 Student Development Services in Higher Education 3(3,0)

Pupil personnel services offered by institutions of higher education.

ED C 804 Theories of Student Development in Higher Education 3(3,0)

Developmental aspects of the young adult age group and the relationship to postsecondary schools and training programs.

ED C 805 Clinical Mental Health Counseling 3(3,0)

History and description of various counseling services provided in agency settings; the type of client populations served and existing legislative acts mandating these services.

ED C 806 Student Affairs Issues 3(3,0)

Introduction to the current issues in the student personnel profession and future challenges facing student affairs departments. *Preq:* ED C 803, 804, or consent of instructor.

ED C 807 Counseling Children and Adolescents 3(3,0)

Theory and techniques in the area of counseling youth in educational institutions and other settings; common challenges faced by children and adolescents, developmental considerations, and evidence-based interventions. *Preq:* ED F 701 and ED C 810; or consent of instructor.

ED C 808 Legal and Ethical Issues in Student Affairs Practice and Counselor Education 3(3,0)

Study of current legal and ethical issues confronting counselor educators and administrators working in student affairs practice and student affairs counseling. Examines a representative sample of key concepts, federal and state court cases and explores the application of legal and ethical issues to student affairs practice and counseling.

ED C 809 Higher Education Administration 3(3,0)

Knowledge, skills and processes essential to effectively administer a program or service in higher education. Examines relationships between environmental factors and strategies for planning and managing student affairs programs and services. *Preq:* Consent of instructor.

ED C 810 Theories and Techniques of Counseling 3(3,0)

Counseling theories and techniques. *Preq:* Consent of instructor.

ED C 811 Multicultural Counseling 3(3,0)

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(3,0) Gathering, interpreting and utilizing educational, social and occupational information; techniques used in placement, survey and follow-up.

ED C 813 Appraisal Procedures 3(2,2) Experience in gathering, interpreting and utilizing data related to the individual; especially significant to counselors. *Preq:* Consent of instructor.

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

ED C 815 Group Counseling 3(3,0) 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. *Preq:* ED C 810, 814.

ED C 816 Introduction to Couples and Family Counseling 3(3,0) Major models and techniques of marriage and family counseling; history, research, legal, ethical and other professional issues; concepts related to family life cycle, healthy family functioning, divorce, ethnicity, problem conceptualization and nontraditional structures. *Preq:* ED C 810 or 814 or consent of instructor.

ED C 817 Crisis Intervention Counseling 3(3,0) Examines diverse crisis situations and the assessment and treatment strategies used by counselors to assist individuals, groups and organizations to manage and resolve crises. *Preq:* ED C 810 or consent of instructor.

ED C 818 Psychopathology for Counselors 3(3,0) Conceptual models employed in classifying and describing various mental disturbances as well as approaches used to alleviate these disturbances. *Preq:* ED C 810, enrollment as Counseling master's student, consent of instructor.

ED C 819 The Contemporary College Student 3(3,0) Analytical approach to the unique character of the contemporary college student, the effects of change on that character and the role of college in enhancing student development in that context. *Preq:* ED L 855 or consent of instructor.

ED C 821 Counseling Psychodiagnostics 3(3,0) Comprehensive overview of the DSM-IV-TR; multiaxial assessment and diagnosis of mental disorders including coding and reporting procedures. *Preq:* ED C 810, 818, enrollment as Counseling master's student, or consent of instructor.

ED C 822 Addictions Counseling 3(3,0) Comprehensive overview of the phenomenon of chemical dependence and addiction; current methods of identification and intervention; awareness of how addictions affect individuals, families, schools and communities. *Preq:* Consent of instructor.

ED C 823 Advanced Counseling Techniques and Strategies 3(3,0) Development of in-depth counseling skills; techniques for working with a wide variety of populations and/or problems. *Preq:* ED C 814, 815, completion of 30 hours in a master's program in Counseling, or certification as a school counselor.

ED C 824 Ethical Issues in Counseling 3(3,0) Explores the ethical standards and dilemmas facing today's counseling professionals, including foundations of ethical principles and ethical decision-making. Students explore ethical issues that cover traditional topics, such as confidentiality, dual relationships, and record keeping; as well as contemporary issues, such as multicultural competence and online counseling, that are prevalent in most counseling settings. *Preq:* ED C 810 or consent of instructor.

ED C 830 School Counseling Practicum 3(1,6) Supervised field experience in counseling and other services in a school setting. To be taken Pass/Fail only. *Preq:* ED C 801, 810, 814; *Preq or coreq:* ED C 807, 815.

ED C 834 Student Affairs Practicum 3(1,6) Supervised field experience in counseling and other student services in a postsecondary school setting. To be taken Pass/Fall only. *Preq:* ED C 803 804, or consent of instructor (100 clock hours).

ED C 836 Clinical Mental Health Practicum 3(1,6) Supervised field experiences in counseling and other services in a community-agency setting. To be taken Pass/Fail only. *Preq:* ED C 805, 814, 815 (or concurrent enrollment), consent of instructor.

ED C 840 Independent Study in Counseling 1-3(1-3,0) Individualized, in-depth study of a particular topic not offered in other courses. Reading, research and independent study are supervised by a faculty member. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.

ED C 841 School Counseling Internship 3-6 In a supervised field experience, students apply knowledge in individual and group counseling, classroom guidance and consultation to assist students in school settings. May be repeated for a maximum of 12 credits. To be taken Pass/Fail only. *Preq:* ED C 830; *preq or coreq:* ED C 812, 813.

ED C 844 Student Affairs Internship 3-6 Application of previous knowledge to professional and postsecondary settings in a supervised field experience in counseling/student services. May be repeated for a maximum of six credits. To be taken Pass/Fail only. *Preq:* ED C 834, consent of instructor.

ED C 846 Clinical Mental Health Counseling Internship 6 Students apply previous knowledge of counseling theory and techniques in a supervised field experience in professional mental health counseling settings. May be repeated for a maximum of 12 credits. *Preq:* ED C 805, 810, 811, 814, 815, 818, 821, 823 (or concurrent enrollment), 836, consent of instructor.

ED C 851 Leadership in School Counseling 3(3,0) Leadership, management and evaluation of school counseling programs. *Coreq:* Must be taken concurrently with first semester of ED C 841.

ED C 885 Selected Topics 1-3(1-3,0) Developing trends in counseling not covered in other courses. May be repeated, but only if different topics are covered.

ED C 915 Internship in Counseling Setting 3(1,6) Postmaster's supervised internship in counseling. Provides experience in counseling as well as coordination of services for a diverse client population. Students participate in direct services with clients in an approved agency. May be repeated for a maximum of six credits. *Preq:* Master's degree in Counseling or related field approved by program coordinator.

ED C 920 Counselor Supervision 3(3,0) Overview of conceptual and empirical literature on counselor supervision that includes models, approaches, techniques, relationship/process issues, legal concerns and ethical considerations. Students develop supervision skills through readings, seminar discussions and supervision of master's-level students. *Preq:* Master's degree in Counseling or related area or consent of instructor.

EDUCATIONAL FOUNDATIONS

ED F (AG ED, CTE) 680 Digital Technology in the 21st Century Classroom 3(2,2) Fundamentals of computer applications for teachers. Develops competence in general computer applications such as word processing and database management and addresses educational uses of the Internet and computer-assisted instruction, with emphasis on legal and ethical issues and the impact of computer technology upon society. *Preq:* Admission to graduate teacher education program.

ED F (AG ED, CTE) 682 Advanced Educational Applications of Microcomputers 3(2,2) Provides students with the knowledge and skills needed to apply microcomputer technology to the utilization and generation of educational software in accordance with sound educational principles. *Preq:* ED F (AG ED, CTE) 480.

ED F 690 Classroom Management 3(3,0) Aids students in developing strategies and plans to manage a classroom effectively. Topics include both time and behavioral management. Students learn how to prevent problems as well as address problems once they have occurred. *Preq:* ED F 302 or PSYCH 201; ED F 334, 335, or suitable alternative; 2.0 minimum grade-point ratio; or consent of instructor.

ED F 697 Instructional Media in the Classroom 3(3,0) Integrated approach to the use of audiovisual media stressing systematic planning, selection, utilization and evaluation as well as production of materials and equipment operation. *Preq:* 2.0 minimum grade-point ratio.

ED F (ED L) 800 Philosophy, Schooling and Educational Policy 3(3,0) See ED L 800.

ED F 801 Human Growth and Development 3(3,0) Theory and research in human development and its impact on the teaching/learning process. *Preq:* ED F 334, 335, 336, or equivalent; classroom teaching experience.

ED F 802 Advanced Educational Psychology 3(3,0) Educational applications of research and theory on objectives, motivation, class climate, class management and learning theory. *Preq:* ED F 302 or equivalent; classroom teaching experience recommended.

ED F 803 Early Adolescent Growth and Development 3(3,0) Theory and research in early adolescent growth and development and the teaching/learning process for middle-grades youth. *Preq:* Graduate standing or consent of instructor.

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

ED F 866 Integrating Service Learning into Curriculum 3(2,3) 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. *Preq:* Teaching certification.

ED F 871 Cultural Diversity in Education 3(3,0) Sociological and anthropological examination of contemporary P12 educational policy issues.

ED F 877 Experimental and Nonexperimental Research Methods in Education I 3(3,0) 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. *Preq:* EX ST 301 or equivalent or consent of instructor; ED F 808 recommended.

ED F 880 Instructional Technology in the Elementary and Middle School 3(2,2) Research-based strategies for integrating instructional technology within the curriculum; methodologies for deploying technology in support of national standards through participation in and development of project-based learning activities. *Preq:* Consent of instructor.

ED F 908 Advanced Educational Tests and Measurement 3(3,0) Theoretical and quantitative aspects of modern and classical test theory from the practitioner's perspective; solving contemporary problems involving intra-student and class level comparisons of student progress; the subsequent impact of assessment on classroom high-stakes accountability decisions. *Preq:* ED F 808 or equivalent; ED F 778 or equivalent.

ED F 970 Identity, Schooling and Democratic Education 3(3,0) Examines current theories of education that address the relationships between race, ethnicity, gender, social class and democratic education in American public schools.

ED F 971 Case Study and Ethnographic Research Methods and Design 3(3,0) Examines case study and ethnographic research methods and design. *Preq:* ED F 878 and 879.

ED F 972 Phenomenology and Grounded Theory Research Methods and Design 3(3,0) Examines phenomenology and grounded theory research methods and design. *Preq:* ED F 878 and 879.

ED F 973 Narrative and Historical Research Methods and Design 3(3,0) Examines narrative and historical research methods and design. *Preq:* ED F 878 and 879.

ED F 974 Emerging Qualitative Research Methods and Design 3(3,0) Examines emerging and lesser-known qualitative research methods and designs, such as self-study, portraiture, arts-based research, photovoice, rhizomatic analysis and critical policy analysis. *Preq:* ED F 878 and 879.

ED F 975 Seminar in Human Growth and Development 3(3,0) Selected topics in human development from any area of the lifespan. Development topics are examined for their impacts on the teaching/learning process, administrative processes and/or counseling approaches. *Preq:* ED F 701 or equivalent and teaching, counseling, or administrative experience.

ED F 976 History of American Education 3(3,0) Historical development of educational purpose and the social and cultural forces which shaped that development.

ED F 977 Experimental and Nonexperimental Research Methods in Education II 3(3,0) Advanced concepts and skills needed to analyze, conduct and evaluate educational research; nonexperimental, quasiexperimental 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. *Preq:* ED F 778, 808, EX ST 801, or equivalent.

ED F 978 Multivariate Educational Research 3(3,0) Investigates descriptive and inferential statistical methods for the exploratory analysis of outcomes in multigroup educational settings in which individuals tend to differ on multiple independent and dependent variables. *Preq:* ED F 878 or consent of instructor.

ED F 979 Qualitative Research in Education 3(3,0) 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. *Preq:* ED F 778, 878, or equivalent.

ED F 980 (ED, ED SP) Internship in Curriculum and Instruction 1-6(0,3-18) See ED 980.

ED F (ED, ED SP) 991 Doctoral Dissertation Research 1-18 See ED 991.

ED F (ED, ED SP) 994 Directed Research 1-4(1-4,0) See ED 994.

EDUCATIONAL LEADERSHIP

ED L 700 Public School Administration 3(3,0) Theoretical bases of school administration; organizational principles, patterns and practices in public schools; decision making; administration of programs and services. *Preq:* Three graduate education courses or consent of instructor.

ED L 705 The Principalship 3(3,0) Roles and responsibilities of the principalship including the organization and administration of schools.

ED L 710 Organizational Theory for School Administrators 3(3,0) Theory of management, communication, human relations, social systems, motivation, contingency, decision making and change. *Preq:* ED L 700.

ED L 715 School and Community Relationships 3(3,0) 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(3,0) School personnel selection, practices and problems. *Preq:* ED L 700, 705.

ED L 725 Legal Phases of School Administration 3(3,0) Legal principles involved in school administration and in court actions. *Preq:* ED L 710.

ED L 730 Techniques of Supervision—the Public Schools 3(3,0) Improving, coordinating and evaluating instruction; modern trends of supervisory practices. *Preq:* ED L 710.

ED L 735 Educational Evaluation 3(3,0) Evaluation theory and design applied to classroom instruction and to evaluation procedures applicable to school center and district programs and projects. *Preq:* ED L 710.

ED L 740 Curriculum Planning and Improvement for School Administrators 3(3,0) Role of leadership in curriculum planning and improvement: curriculum evaluation and development, change, programmatic requirements, cocurriculum, organization, scheduling, planning, management and technology. *Preq:* ED L 710.

ED L 745 School Finance 3(3,0) School finance relative to programs, revenues and experience. *Preq:* ED L 735.

ED L 750 Elementary Principal and Supervisor Field Experience I 3(1,4) First practicum in a series of two with an experienced elementary/middle (pre-K-8) school principal or supervisor. ED L 750 and 751 must be taken in a sequence in a single academic year. *Preq:* ED L 705.

ED L 751 Elementary Principal and Supervisor Field Experience II 3(1,4) Second practicum in a series of two with an experienced elementary/middle (pre-K-8) school principal or supervisor. ED L 750 and 751 must be taken in a sequence in a single academic year. *Preq:* ED L 750.

ED L 755 Secondary Principal and Supervisor Field Experience I 3(1,4) First practicum in a series of two with an experienced secondary (grades 7-12) principal or supervisor. ED L 755 and 756 must be taken in a sequence in a single academic year. *Preq:* ED L 705.

ED L 756 Secondary Principal and Supervisor Field Experience II 3(1,4) Second practicum in a series of two with an experienced middle/high school (grades 7-12) principal or supervisor. ED L 755 and 756 must be taken in a sequence in a single academic year. *Preq:* ED L 755.

ED L 765 Assessment in Higher Education 3(3,0) Outcomes assessment and institutional effectiveness movement including assessment techniques, instrument selection, analysis of assessment data and reporting of assessment findings. *Preq:* Consent of instructor.

ED L 795 School Leadership Information Systems 3(2,2) 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.

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

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

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

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

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

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

ED L 839 Research Methods in Educational Leadership 3(3,0) 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. *Preq:* ED L (ED F) 800, 805, 820, consent of instructor.

ED L 840 Field Problems in School Administration and Supervision of Instruction 3(2,3) Application of research techniques and practices in solution of field problems in school administration and supervision. *Preq:* ED F 778, ED L 700.

ED L 850 Practicum in School System Leadership I 3 First in a two-semester practicum with an experienced school-system-level administrator or supervisor. *Preq:* ED L (ED F) 800, 805, 815, or consent of instructor.

ED L 851 Practicum in School System Leadership II 3 Second in a two-semester practicum with an experienced school-system-level administrator or supervisor. *Preq:* ED L 850.

ED L 855 Applied Research and Evaluation in Higher Education 3(3,0) Basic issues of measurement emphasizing questionnaire development, scales and measures commonly used in higher education research, assessment and program evaluation.

ED L 885 Selected Topics in Educational Administration 1-3(1-3,0) Current literature and results of current research. Topics vary from year to year. May be repeated for a maximum of six credits.

ED L 895 Advanced Field Designs for Educational Personnel 3(2,1) Presents state-of-the-art field designs and multivariate statistics for education personnel; and provides hands-on experience with advanced statistical procedures using PASW and AMOS. Addresses demands by publicists and policy makers, and is particularly valuable for PhD students in education pursuing research in curriculum, policy, diversity and leadership. *Preq:* ED F 789 or EX ST 801, or equivalent.

ED L 900 Principles of Educational Leadership 3(3,0) Advanced leadership theory; the nature of leadership, major theories of leadership and their application in educational organizations. *Preq:* Admission to PhD program in Educational Leadership.

ED L 905 Theory and Practice in Educational Leadership 3(3,0) Advanced organizational and leadership theory; major theories of organization and their applications in understanding the roles of governmental agencies in society. *Preq:* Admission to the doctoral program.

ED L 910 Introductory Doctoral Seminar 3(3,0) 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. *Preq:* Consent of instructor.

ED L 911 Systematic Inquiry in Educational Leadership 3(3,0) Introduces entry level doctoral students to multiple approaches in inquiry practices for the field of educational leadership. *Preq:* Admission to doctoral program in Educational Leadership or equivalent and/or consent of instructor.

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

ED L 925 Instructional Leadership 3(3,0) Preparation for a career in educational leadership; the principal's functions in the effective school's movement as incorporated in instructional leadership.

ED L 935 History of Higher Education 3(3,0) Development of higher education from the 11th century to the present with emphasis on the United States.

ED L 950 Educational Policy Studies 3(3,0) Critical analysis of the sources and nature of educational policy and how policy is developed, administered and assessed for public schools. *Preq:* Admission to doctoral studies.

ED L (VT ED) 955 The Two-Year College 3(3,0) Historical developments, functions, organization and administration of the two-year college. *Preq:* Admission to doctoral studies or consent of instructor.

ED L 960 Legal Principles in the Administration of Institutions of Higher Education 3(3,0) General principles of higher education law from the points of view of statute and common law practice. *Preq:* Admission to doctoral studies or consent of instructor.

ED L 962 Governance in Higher Education 3(3,0) Exposes students to literature on the organization and governance of higher education institutions. Helps future leaders of higher education understand the distinctive organizational and behavioral features of postsecondary institutions and gives them the knowledge base to make better decisions for their institutions. *Preq:* Admission to doctoral studies and consent of instructor.

ED L 965 Higher Education Finance 3(3,0) Higher education finance relative to sources of revenue, expenditures and planning.

ED L 970 Foundations of Higher Education 3(3,0) Survey of American higher education including its historical, political, philosophical and social aspects. *Preq:* Admission to doctoral studies.

ED L 972 Ethics in Educational Leadership 3(3,0) The ethical issues involved in administering educational institutions; moral leadership, ethical work environments and decision-making models.

ED L 975 College Teaching 3(3,0) Comprehensive preparation for teaching at the college level: course design and development around student outcomes/objectives; teaching strategies that motivate today's diverse students and promote active, multimodal, collaborative and experiential learning; assessment of student learning and teaching effectiveness; institutional issues; and job search preparation. *Preq:* Consent of instructor.

ED L 976 External Effectiveness in Higher Education 3(3,0) Optimum structures and strategies for fund raising, public relations, constituent relations, governmental affairs and governing boards necessary for a college or university to communicate effectively with its constituents.

ED L 977 Diversity Issues in Higher Education 3(3,0) Students read research and analyze information highlighting the complex nature of diversity issues in postsecondary environments. Students also examine the history of student diversity in higher education and explore the impact of multicultural higher educational environments on students, faculty and postsecondary institutions. *Preq:* Enrollment in the Ph.D. Educational Leadership program or consent of instructor.

ED L 980 Current Issues in Educational Leadership 1-3(1-3,0) Topics and issues as determined by the needs of the students and the instructor. *Preq:* Graduate standing, consent of instructor.

ED L 985 Internship in Educational Leadership I 3 First in a two-semester internship to provide experience in leadership role under the guidance of an experienced field mentor at the student's chosen level of specialization in educational leadership (public schools or institutions of higher education). *Preq:* ED L 900, 905, 910, or consent of advisor.

ED L 986 Internship in Educational Leadership II 3 Second in a two-semester internship to provide experience in leadership role under the guidance of an experienced field mentor at the student's chosen level of specialization in educational leadership (public schools or institutions of higher education). *Preq:* ED L 985.

ED L 988 Directed Research 3(3,0) First in a sequence of three required post-candidacy courses in which students refine the conceptual basis for their research questions in directed study with faculty. *Preq:* Admission to doctoral candidacy or consent of instructor.

ED L 989 Advanced Doctoral Seminar I 3(3,0) Explores educational leadership topics. Culminates in the selection of a topic for presentation and approval and the development of Chapter I of a prospectus. *Preq:* ED L 900, 905, 910, consent of instructor.

ED L 990 Advanced Doctoral Seminar II 3(3,0) Seminar for advanced students focusing on the preparation of dissertation Chapters I-III.

ED L 991 Doctoral Dissertation Research 1-18

ELECTRICAL AND COMPUTER ENGINEERING

E C E 604 Semiconductor Devices 3(3,0) Consideration of the principles of operation, external characteristics and applications of some of the more important semiconductor devices available. *Preq:* E C E 320. *Coreq:* MTHSC 311 or 434.

E C E 606 Introduction to Microelectronics Processing 3(3,0) Microelectronic processing, MOS and bipolar monolithic circuit fabrication, thick and thin film hybrid fabrication, applications to linear and digital circuits, fundamentals of device design. *Preq:* E C E 320. *Coreq:* MTHSC 311 or 434.

E C E 617 Elements of Software Engineering 3(3,0) Foundations of software design, reasoning about software, the calculus of programs, survey of formal specification techniques and design languages. *Preq:* E C E 322, 352, MTHSC 419.

E C E 618 Power System Analysis 3(3,0) Study of power system planning and operational problems. Subjects covered include load flow, economic dispatch, fault studies, transient stability and control of problems. System modeling and computer solutions are emphasized through class projects. *Preq:* E C E 360, 380.

E C E 619 Electric Machines and Drives 3(3,0) 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. *Preq:* E C E 321, 360, 380. *Coreq:* MTHSC 434 or consent of instructor.

E C E 622 Electronic System Design I 3(2,2) Emphasizes the 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. *Preq:* E C E 321, 330, 360, 371, 381.

E C E 629 Organization of Computers 3(3,0) Computer organization and architecture. Topics include 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. *Preq:* E C E 272 or consent of instructor.

E C E 630 Digital Communications 3(3,0) Introduction to modern digital communication systems emphasizing modulation and detection, taking into account the effects of noise. *Preq:* E C E 317, 330.

E C E 632 Instrumentation 3(3,0) Theory and analysis of transducers and related circuits and instrumentation. Generalized configurations and performance characteristics of instruments are considered. Transducer devices for measuring physical parameters such as motion, force, torque, pressure, flow and temperature are discussed. *Preq:* E C E 321. *Coreq:* MTHSC 311 or 434.

E C E 635 Grounding and Shielding 3(3,0) Introduction to electromagnetic compatibility concepts and techniques for students who will be designing or working with electronic systems when they graduate. Topics include electromagnetic interference and noise control, crosstalk and signal integrity, grounding, filtering, shielding, circuit board layout, lighting and electrostatic discharge protection. *Preq:* E C E 381.

E C E 636 Microwave Circuits 3(3,0) 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. *Preq:* E C E 381 or equivalent. *Coreq:* MTHSC 311 or 434.

E C E 638 Computer Communications 3(3,0) Digital data transmission techniques, modems and communications channels, communications software and protocols, multiprocessors and distributed processing; concurrency and cooperation of dispersed processors. *Preq:* Senior standing in Electrical or Computer Engineering or Computer Science or consent of instructor.

E C E 639 Fiber Optics 3(3,0) Underlying principles of design for optical fibers in practical systems are covered. Optical fiber as a waveguide is examined using wave optics and ray optics. Design criteria for using mono- and multi-mode fibers are discussed. Other topics include fabrication and measurement. *Preq:* E C E 381. *Coreq:* MTHSC 434 or consent of instructor.

E C E 640 Performance Analysis of Local Computer Networks 3(3,0) Introduction to design and performance analysis of local computer networks. Emphasis is on performance analysis of representative multi-access procedures. Three common types of networks are considered in detail. *Preq:* E C E 272, 317.

E C E 642 Knowledge Engineering 3(3,0) Introduction to theoretical and practical aspects of knowledge engineering or applied artificial intelligence. Topics include 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 is required. *Preq:* E C E 322, 352.

E C E 646 Antennas and Propagation 3(3,0) Study of the theoretical and practical aspects of antenna design and utilization, input impedances, structural considerations and wave propagation. *Preq:* E C E 330, 381 or 436; MTHSC 311 or 434.

E C E 649 Computer Network Security 3(1,4) Hands-on practicum in the administration and security of modern network service with an emphasis on intrusion prevention techniques, detection and recovery. *Preq:* Graduate standing in a technical field.

E C E 655 Robot Manipulators 3(3,0) Analysis of robot manipulator systems with special focus on interaction of these technologies with society. Emphasis is on rigid-link robot manipulator systems. Topics include history of robot technology, kinematics, dynamics, control and operator interfaces. Case studies reinforce impact of robot technology on society and vice versa. *Preq:* MTHSC 206, 311, or consent of instructor.

E C E 659 Integrated Circuit Design 3(2,2) Design concepts and factors influencing the choice of technology; fundamental MOS device design; silicon foundries, custom and semicustom integrated circuits; computer-aided design software/hardware trends and future developments; hands-on use of CAD tools to design standard library cells; systems design considerations, testing and packaging. *Preq:* E C E 321. *Coreq:* MTHSC 311 or 434.

E C E 667 Introduction to Digital Signal Processing 3(3,0) Introduction to characteristics, design and applications of discrete time systems; design of digital filters; Fast Fourier Transform (FFT); LSI hardware for signal processing applications. *Preq:* E C E 330.

E C E 668 Embedded Computing 3(2,2) Principles of using computing in the larger context of a system. Topics include bus and processor design types (e.g. microprocessor, microcontroller, DSP), codecs, digital circuit power management, real time scheduling and embedded operating systems. Lab work consists of projects on embedded hardware (e.g. PC-104+). *Preq:* E C E 223, 371; or consent of instructor.

E C E 673 Introduction to Parallel Systems 3(3,0) Introduces parallel computer architectures and their programming. Includes an introduction to MPI and OpenMP and a number of engineering problems, including numerical simulations. Introduces scalability analysis. *Preq:* CP SC (E C E) 322 or E C E 329 or equivalent.

E C E 692 Special Problems 1-3 Special assignment in electrical or computer engineering. Typical assignments include computer programs, term papers, technical literature searches, hardware projects and design project leadership. May be taken only once for credit.

E C E 693 Selected Topics 1-3(1-3,0) Classroom study of current and new technical developments in electrical and computer engineering. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* Consent of instructor.

E C E 701 Master of Engineering Design Project 1-6 Practical problems in engineering analysis and design culminating in the written report required for the MEngr degree. To be taken Pass/Fail only. May be repeated for a maximum of six credits.

E C E 720 Digital Communication Engineering I 3(3,0) Analysis of modulation and detection for digital communication engineering systems degraded by noise. *Preq:* E C E 317, 330 and enrollment in the Electrical Engineering Master of Engineering program.

E C E 757 Error Control Block Coding 3(3,0) Analysis and design of error control coding and decoding for the reliable transmission of digital data. *Preq:* E C E 317 and enrollment in the Electrical Engineering Master of Engineering program.

E C E 801 Analysis of Linear Systems 3(3,0) Foundations of linear system analysis; matrix algebra, linear graph theory and operational mathematics applied to formulation and solution of system equations in time and frequency domains.

E C E 802 Electric Motor Control 3(3,0) 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. *Preq:* E C E 434.

E C E 807 Computer Methods for Power Systems Analysis 3(3,0) 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. *Preq:* E C E 418.

E C E 811 Integrated Circuit Design 3(2,2) 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; the hands-on use of CAD tools to design MOS standard cells; systems design, testing and packaging. *Preq:* E C E 459.

E C E 816 Electric Power Distribution System Engineering 3(3,0) 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. *Preq:* E C E 418 or consent of instructor.

E C E 817 Power System Transients 3(3,0) 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. *Preq:* E C E 418 or consent of instructor.

E C E 818 Random Process Applications in Engineering 3(3,0) 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. *Preq:* E C E 317 and 330 or consent of instructor.

E C E 819 Detection and Estimation Theory 3(3,0) 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. *Preq:* E C E 630, 818 or 820.

E C E 820 Digital Communication Systems I 3(3,0) Modern communications systems emphasizing modulation and methods of taking into account effects of noise on various systems. *Preq:* E C E 317, 330

E C E 821 Digital Communication Systems II 3(3,0) Continuation of E C E 820.

E C E 822 Information Theory 3(3,0) 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. *Preq:* E C E 317 or equivalent.

E C E 823 Integrated Circuit Technology 3(3,0) 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. *Preq:* Consent of instructor.

E C E 824 Power System Protection 3(3,0) 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. *Preq:* E C E 418 or consent of instructor. *Coreq:* MTHSC 434 or consent of instructor.

E C E 825 Solid-State Electronics 3(3,0) Modern physics approach to electrons in solids; elementary quantum mechanics; statistics; plasmas; band theory; application of these principles to modern amplifiers; e.g., the traveling-wave tube, tunnel diode, masers, and parametric amplifiers.

E C E 827 Finite Difference Methods in Electromagnetics 3(3,0) Investigates finite-difference methods (FD) as applied to electromagnetics; FD approximations, error, stability and numerical dispersion; solution of Poisson's, Helmholtz and wave equations; banded matrices, iterative methods and eigensolutions; the finite-difference time-domain method, Yee Lattice, mesh truncation methods, perfectly matched layers, source conditions, near-to-far field transformation, subcellular modeling for fine features and wide-band characterization. *Preq:* E C E 436 or 446 or equivalent. *Coreq:* E C E 830.

E C E 828 Guided Waves, Wave Propagation and Radiation in Stratified Media 3(3,0) Covers several important topics of applied electromagnetics, including advanced transmission-line theory for guided electromagnetic waves, analysis of electromagnetic wave propagation in layered media and computation of electromagnetic radiation in stratified regions. *Preq:* E C E 829, 830.

E C E 829 Special Functions in Engineering 3(3,0) Complex calculus and analytic functions; origin of special functions in engineering; series and integral representations of special functions; properties and applications of gamma, Bessel, Legendre, Chebyshev, etc. functions; computation of special functions; applications in selected engineering problems. *Preq:* Consent of instructor.

E C E 830 Electromagnetics 3(3,0) Wave equations and waves, electromagnetic potentials, theorems and advanced concepts, guided waves, radiation, boundary value problems and simple Green's functions. *Preq:* E C E 380, 381; or equivalent.

E C E 831 Advanced Electromagnetic Theory 3(3,0) Advanced boundary-value problems in cylindrical and spherical coordinates, special functions, Sommerfeld integrals, Green's functions and integral equations. *Preq:* E C E 830.

E C E 834 Asymptotic Methods and Diffraction Theory 3(3,0) 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; application of diffraction from edges and curved surfaces to scattering and antenna problems. *Preq:* E C E 830.

E C E 835 Finite Element Methods in Electromagnetics 3(3,0) Finite-element methods (FEM) as applied to electromagnetics; fundamentals of list-linked FEM data structures, sparse matrix solutions, edge-based vector bases, radiation boundary conditions and perfectly absorbing media. *Coreq:* E C E 830.

E C E 839 Integral Equations in Electromagnetics 3(3,0) Integral equation formulation in electromagnetics, solution techniques, moment methods and application to practical problems. *Preq:* E C E 830 or consent of instructor.

E C E 840 Physics of Semiconductor Devices 3(3,0) 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 couples devices and solar cells; charge control concepts, transit time effects, surface-type devices and practical aspects of device process. *Preq:* E C E 404, 406.

E C E 842 Computer Architecture 3(3,0) 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. *Preq:* E C E 429 or equivalent.

E C E 844 Digital Signal Processing 3(3,0) 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. *Preq:* E C E 467.

E C E 846 Digital Processing of Speech Signals 3(3,0) 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. *Preq:* E C E 467.

E C E 847 Digital Image Processing 3(3,0) Review of fundamental concepts, issues and algorithms in image processing. Includes image formation, file formats, filters, edge detection, stereo, motion and color. *Preq:* E C E 467.

E C E 848 Telecommunication Network Modeling and Analysis 3(3,0) Protocols, modeling and analysis of telecommunication networks with emphasis on quantitative performance modeling of networks and systems using packet switching and circuit switching techniques. *Preq:* CP SC 825 or E C E 438.

E C E 849 Advanced Topics in Computer Communications 3(3,0) 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. *Preq:* E C E 438 or 440, consent of instructor.

E C E 850 QoS in Wireless Networks 3(3,0) Design principles and core techniques for quality assured communications in Internet and wireless networks. Introduces protocols and mathematical foundations of IntServ, DiffServ and traffic engineering. Covers mobility aware, channel adaptive and cross layer QoS assurance techniques. *Preq:* E C E 638 and 640, or consent of instructor.

E C E 851 Advanced Topics in Computer Architecture 3(3,1) Analysis and design of multiprocessor and modular computer systems; recent developments in integration, fabrication and application of multiprocessor systems. *Preq:* E C E 842.

E C E 854 Analysis of Robotic Systems 3(3,0) Methods of designing and operating robotics systems for advanced automation; on-line identification and description of 3-D objects by digitized images; off-line collision-free path planning and on-line collision avoidance traveling using artificial intelligence. *Preq:* M E (E C E) 456 or consent of instructor.

E C E 855 Artificial Intelligence 3(3,0) 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 database structure and inference strategies; examples of LISP, PROLOG, and OPS5. *Preq:* E C E 442.

E C E 856 Pattern Recognition 3(3,0) 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(3,0) Principles of algebraic coding and its application to transmission of information over noisy communications channels; introduction to abstract algebra; code performance bounds; code representations; linear codes of the Hamming and Bose-Chandnuri types and burst-error correcting codes; problems of implementation and decoding. *Preq:* E C E 317 or equivalent.

E C E (M E) 859 Intelligent Robotic Systems 3(3,0) 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. *Preq:* E C E (M E) 854.

E C E 860 Advanced Coding Theory 3(3,0) 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. *Preq:* E C E 630 or 820; and 857.

E C E 862 Real Time Computer Application in Power Systems 3(3,0) 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. *Preq:* E C E 418.

E C E 863 Power System Dynamics and Stability 3(3,0) 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. *Preq:* E C E 418, 419.

E C E (ARCH) 868 Architectural Robotics 3(3,0) Focuses on understanding, developing and testing robotic systems for the built environment. Collaborative teams of students from Electrical and Computer Engineering and Architecture and their allied disciplines study and develop working robotic prototypes responsive to challenges and opportunities of living in today's built and natural environments. *Preq:* Consent of instructor.

E C E 869 Advanced Kinematics in Robotics 3(3,0) Complex robotic systems, such as multi-fingered robot hands, dual-armed robots and multi-joint "snakelike" robots; kinematic redundancy, load distribution and dexterous manipulation; effective modeling and solution techniques for these types of underconstrained systems. *Preq:* E C E 409, 455

E C E 872 Artificial Neural Networks 3(3,0) 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. *Preq:* MTHSC 311 or consent of instructor, graduate standing.

E C E 873 Parallel and Distributed Systems 3(3,0) Design, analysis and evaluation of algorithms for parallel and distributed computer systems; time complexity, speedup, efficiency and isoefficiency; communication costs; numerical algorithms including solving systems of equations (both sparse and dense) as well as symbolic algorithms; substantial parallel programming projects.

E C E 874 Advanced Nonlinear Control 3(3,0) Basics of nonlinear control based on Lyapunov techniques; adaptive control design, robust control design and observer design; understanding and development of Lyapunov control design tools. *Preq:* E C E 801 or equivalent.

E C E 877 Computer Vision 3(3,0) Investigation into fundamental concepts, issues and algorithms in computer vision. Includes segmentation, texture, detection, 3-D reconstruction, camera calibration, shape and energy minimization. *Preq:* E C E 847

E C E 891 Master's Thesis Research 1-12

E C E 892 Special Problems in Electrical and Computer Engineering 1-3(1-3,0) Term paper, special design, or other problems in electrical and computer engineering approved by the instructor. May not be used for investigation associated with the MS thesis or the engineering report. May be repeated for credit.

E C E 893 Selected Topics in Electrical and Computer Engineering 1-3(1-3,0) 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 credit. *Preq:* Consent of instructor.

E C E 903 Computer Architecture Seminar 1(1,0) Recent research publications related to computer architecture including parallel systems, distributed computing, reconfigurable architectures and software development for high performance computing. Students read and discuss one research paper weekly and present one research paper each semester. May be repeated for a maximum of three credits. *Preq:* Consent of instructor.

E C E 904 Computer Vision Seminar 1(1,0) Review of recent research publications related to computer vision including tracking, correspondence, reconstruction and segmentation. Students read and discuss one research paper per week and present one research paper each semester. May be repeated for a maximum of three credits.

E C E 905 Computer Security Seminar 1(1,0) Review of current research publications related to computer and network security including software assurance, biometrics, applied cryptography and other security relevant topics. Students read and discuss one research paper weekly and present one or more research papers each semester. May be repeated for a maximum of three credits. *Preq:* Consent of instructor.

E C E 906 Mechatronic Systems 1(1,0) Mechatronics describes the synergistic use of tools from mechanical engineering, electrical engineering, control engineering, systems engineering and computer engineering to create new classes of systems and system performance. In this seminar, students study current advances and results from this evolving field. May be repeated for a maximum of three credits.

E C E 991 Doctoral Dissertation Research 1-12

ELEMENTARY EDUCATION

ED EL 760 Curriculum Development in the Elementary School 3(3,0) Analysis of trends and practices relative to elementary curriculum planning. Designed to develop an understanding of the essential elements of curriculum decisions followed by the process of improving the curriculum. *Preq:* ED F 701, 702, or consent of instructor.

ED EL 804 Advanced Methods of Teaching in the Elementary School 3(3,0) Principles and practices involved in promoting effective learning in elementary schools; analysis and evaluation of educational models and research. *Preq:* ED EL 760 or consent of instructor.

ED EL 826 Elementary School Science: Theory to Practice 3(3,0) In-depth study of current research and trends in science theory, teaching strategies and curriculum development from birth to grade six. *Preq:* Admission to MEd program in Early Childhood or Elementary Education or consent of instructor.

ED EL 831 Elementary School Social Studies: Theory to Practice 3(3,0) In-depth study of current research and trends in Social Studies theory, teaching strategies and curriculum development from kindergarten to grade six. *Preq:* Admission to Masters level study in Elementary Education or consent of instructor.

ED EL 890 Education Research Project 3(2,3)

Students select, with approval of professor, and conduct research on an education issue of suitable scope. Oral, written and visual presentation of the research project is required. Students must enroll during final semester. *Preq:* Consent of instructor.

ED EL 892 Elementary School Mathematics: Theory to Practice 3(3,0)

In-depth study of current research and trends in mathematics theory, teaching methods and curriculum development from birth to grade six. *Preq:* Admission to MEd program in Early Childhood or Elementary Education or consent of instructor.

ED EL 937 Designing Elementary Curriculum 3(3,0)

Theoretical issues and guidelines for educators engaged in the curriculum development process at the elementary level. *Preq:* Admission to the PhD program in Curriculum and Instruction, ED 954, 955, 956.

ED EL 938 Teacher as Researcher 3(3,0)

Various methodologies of field-based research. Students complete a literature review and design a field-based research project. *Preq:* Admission to the PhD program in Curriculum and Instruction, ED 878, 879, EX ST 801, one of the following: EDSEC 846, 847, 848, 849, EDLT 944.

ENGINEERING AND SCIENCE EDUCATION

ESED 800 Engineering and Science Education Research Methods 1(1,0)

Brings contemporary issues in engineering and science education research into the classroom. Experts from academia, industry and the corporate world give presentations on various issues, including recruitment of minorities, retention issues, technology integration into engineering curricula, distance learning, engineering content into K-12 curriculum, learning theories and education policy issues.

ESED 820 Teaching Undergraduate Engineering 3(3,0)

Designed for engineering graduate students seeking a career in academe. Includes both discussion and practice of effective teaching techniques, assessments and technologies, as well as an overview of current engineering education research.

ESED 821 Teaching Undergraduate Science 3(3,0)

Graduate students in the sciences who are interested in an academic career learn to improve their teaching by incorporating results of modern science education research, including effective teaching techniques, assessment issues and the use of technology. *Preq:* Enrollment in a science, technology, engineering or mathematics graduate program.

ESED 825 Engineering and Science Student Strategies 3(3,0)

Elucidates relationships between students' prior knowledge, problem solving skills and cognitive processes in undergraduate engineering and science courses. Focuses on steps involved in problem solving, how misconceptions are manifested in students' work and how instruction can be structured to address those misconceptions.

ESED 850 Special Topics in Engineering and Science Education 14(14,0)

Advanced topics intended to develop in-depth areas of particular student interest. May be repeated for a maximum of 15 credits. *Preq:* Consent of instructor.

ESED 861 Practicum in Engineering and Science Education 1-3(1-3,0)

Practicum that includes teaching or mentoring undergraduates in Engineering and Science (General Engineering or student's home department). Counts towards a Certificate in Engineering and Science Education. May be repeated for a maximum of three credits.

ESED 870 Theories of Engineering and Science Learning 3(3,0)

Provides graduate students in engineering and the sciences a foundation in theories of learning with a particular focus on their application to the teaching and learning of science, technology, engineering or mathematics. *Preq:* Enrollment in a science, technology, engineering or mathematics graduate program.

ESED 871 Engineering and Science Education Research Methods 3(3,0)

Introduces methods and tools available for conducting pedagogically sound engineering and science education research. Quantitative, qualitative and mixed methods are discussed and practiced.

ESED 875 Current Issues in STEM Education Research 3(3,0)

Designed for doctoral students interested in STEM education research. Covers research issues of current relevance to a breadth of STEM education fields. Students have the opportunity to investigate a current topic of their choosing. *Preq:* Enrollment in a PhD program.

ESED 888 Preparing for the Professoriate 3(3,0)

Prepares students for obtaining a faculty position and achieving tenure in science and engineering disciplines. Students develop a professional portfolio, prepare for the application/interview process and write a mini-proposal. *Preq:* Enrollment in a doctorate program in the College of Engineering and Science.

ESED 991 Dissertation Research and Writing 1-12(1-12,0)

This course is designed for students who are conducting research and/or writing their dissertation under the supervision of a faculty member in the Engineering and Science Education. Credit is to be arranged. *Preq:* Enrollment in a doctorate program in the College of Engineering and Science.

ENGINEERING GRAPHICS

E G 690 Special Topics in Engineering and Computer Graphics 1-3(1-3,0)

Comprehensive study of any computer-aided topic in engineering graphics not covered in other courses. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.

ENGLISH

ENGL 600 The English Language 3(3,0)

Studies in English usage and historical development of the language. *Preq:* ENGL 310 or consent of instructor.

ENGL 601 Grammar Survey 3(3,0)

Survey of modern grammars, focusing on the impact of structural grammar on traditional grammar. Recommended for English teachers. *Preq:* ENGL 310 or consent of instructor.

ENGL 607 The Medieval Period 3(3,0)

Selected works of Old and Middle English literature, excluding Chaucer. *Preq:* ENGL 310 or consent of instructor.

ENGL 608 Chaucer 3(3,0)

Selected readings in Middle English from *The Canterbury Tales* and other works by Chaucer. *Preq:* ENGL 310 or consent of instructor.

ENGL 610 Drama of English Renaissance 3(3,0)

Selected readings in non-Shakespearean dramatic literature of the 16th and 17th centuries. *Preq:* ENGL 310 or consent of instructor.

ENGL 611 Shakespeare 3(3,0)

Study of selected tragedies, comedies and history plays of Shakespeare. Required of all English majors. *Preq:* ENGL 310 or consent of instructor.

ENGL 614 Milton 3(3,0)

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. *Preq:* ENGL 310 or consent of instructor.

ENGL 615 The Restoration and Eighteenth Century 3(3,0)

Readings in Dryden, Swift, Pope and Dr. Johnson. *Preq:* ENGL 310 or consent of instructor.

ENGL 616 The Romantic Period 3(3,0)

Readings from the poetry and critical prose of Blake, Wordsworth, Coleridge, Byron, Shelley, Keats and other representative figures. *Preq:* ENGL 310 or consent of instructor.

ENGL 617 The Victorian Period 3(3,0)

Readings from the poetry and nonfiction prose of selected Victorian authors, including works of Carlyle, Tennyson, Browning, Arnold and other representative figures. *Preq:* ENGL 310 or consent of instructor.

ENGL 618 The English Novel 3(3,0)

Study of the English novel from its 18th century beginnings through the Victorian period. *Preq:* ENGL 310 or consent of instructor.

ENGL 619 Postcolonial and World Literatures 3(3,0)

Selected readings in postcolonial literature and theory, focusing on issues of nationalism, migration, resistance, race, language and master narratives. *Preq:* ENGL 310 or consent of instructor.

ENGL 620 American Literature to 1799 3(3,0)

Focused study of authors, movements, themes, critical approaches and genres in literature of colonial and early national America from early European explorations of the continent to 1799. *Preq:* ENGL 310 or consent of instructor.

ENGL 621 American Literature from 1800 to 1899 3(3,0)

Focused study of authors, movements, themes, critical approaches and genres in the poetry and prose of major American authors and literary movements from the nineteenth century. *Preq:* ENGL 310 or consent of instructor.

ENGL 625 The American Novel 3(3,0)

Survey of the most significant forms and themes of the American novel from its beginnings to 1900. *Preq:* ENGL 310 or consent of instructor.

ENGL 626 Southern Literature 3(3,0)

Intellectual and literary achievement of the South from 1607 to the present, with emphasis upon the writers of the 19th century. *Preq:* ENGL 310 or consent of instructor.

ENGL 628 Contemporary Literature 3(3,0)

Focuses on American, British and other fiction, poetry and drama from the Post-World War II to the present. *Preq:* ENGL 310 or consent of instructor.

ENGL 629 Dramatic Literature I 3(3,0) Selected reading in dramatic literature from the classical era of Greece and Rome to the Renaissance. *Preq:* ENGL 310 or consent of instructor.

ENGL (THEA) 630 Dramatic Literature II 3(3,0) Principles and progress of drama from the Restoration to the present; analysis of representative plays; critical reports; discussion of trends in dramatic literature. *Preq:* ENGL 310 or consent of instructor.

ENGL 631 Modern Poetry 3(3,0) The modern tradition in English and American poetry from Yeats to the present; relevant critical essays. *Preq:* ENGL 310 or consent of instructor.

ENGL 632 Modern Fiction 3(3,0) American and British novels and short stories of the 20th century. *Preq:* ENGL 310 or consent of instructor.

ENGL 633 The Anglo-Irish Literary Tradition 3(3,0) 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 specifically Irish aspects of their works. *Preq:* ENGL 310 or consent of instructor.

ENGL 634 Environmental Literature 3(3,0) 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. *Preq:* ENGL 310 or consent of instructor.

ENGL 635 Literary Criticism 3(3,0) Major critical approaches to literature. *Preq:* ENGL 310 or consent of instructor.

ENGL 636 Feminist Literary Criticism 3(3,0) Introduction to the germinal works of feminist literary theory and criticism. Outlines the development of modern literary criticism by studying feminist versions of the major critical methodologies. *Preq:* ENGL 310 or consent of instructor.

ENGL 637 Directed Studies 1-3(1-3,0) 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 registration period of the semester preceding the one in which directed studies will occur. May be repeated by arrangement with the department. *Preq:* ENGL 310 or consent of instructor.

ENGL 640 Literary Theory 3(3,0) Examination of how approaches such as Marxism, Psychoanalysis, Feminism, Deconstruction, New Historicism, Post Colonialism, Cultural Studies and Queer Theory answer the question, "What is literature?" *Preq:* ENGL 310 or consent of instructor.

ENGL 641 Literary Editing 3(3,0) Examination of how the theories and practices of editing construct texts, stressing the problems and objectives of editing and providing practical experience with literary editing. *Preq:* Sophomore literature.

ENGL 642 Cultural Studies 3(3,0) Investigation of the similarities and connections between a wide variety of cultural products, events and practices—from fast food through opera to on-line shopping—using theories ranging from Marxism to hybridity. *Preq:* ENGL 310 or consent of instructor.

ENGL 644 Renaissance Literature 3(3,0) Selected readings in non-Shakespearean British literature from 1500–1660. Includes drama, poetry and prose. *Preq:* ENGL 310 or consent of instructor.

ENGL 645 Fiction Workshop 3(3,0) Workshop in the creative writing of prose fiction. May be repeated once for credit. *Preq:* ENGL 345 or consent of instructor.

ENGL 646 Poetry Workshop 3(3,0) Workshop in the creative writing of poetry. May be repeated once for credit. *Preq:* ENGL 346 or consent of instructor.

ENGL (THEA) 647 Playwriting Workshop 3(0,3) See THEA 647.

ENGL 648 Screenwriting Workshop 3(2,3) Workshop in the creative writing of screenplays. May be repeated once for credit. *Preq:* ENGL 348 or consent of instructor.

ENGL 649 Creative Non-Fiction 3(3,0) Advanced workshop in writing non-fiction prose for magazine and freelance markets. *Preq:* ENGL 312 or 334 or consent of instructor.

ENGL 650 Film Genres 3(2,3) 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. Also considers nontraditional genres, screen irony, genre theory and historical evolution of genres. Topics vary. *Preq:* ENGL 357 or consent of instructor.

ENGL (COMM) 651 Film Theory and Criticism 3(2,3) Advanced study into the theory of film/video making emphasizing understanding a variety of critical methods to approach a film. Examines the history of film theory and defines the many schools of film criticism, including realism, formalism, feminism, semiotics, Marxism and expressionism. *Preq:* ENGL 357 or consent of instructor.

ENGL 652 Great Directors 3(2,3) Intensive study of one to three film directors with an emphasis on understanding the entire canon of each director. Students study similarities in techniques, shifts in thematic emphasis and critical methodologies for approaching the works of each director. Topics vary. *Preq:* ENGL 357 or consent of instructor.

ENGL 653 Sexuality and the Cinema 3(2,3) Examination of male/female sexual roles and their evolution in American genre films, avant-garde cinema and international films. Includes the study of movies in relation to cultural values and social stereotypes, introduction to feminist film theory, and consideration of film pornography. *Preq:* ENGL 357 or consent of instructor.

ENGL 655 American Humor 3(3,0) Native American humor of the 19th and 20th centuries. *Preq:* 310 or consent of instructor.

ENGL (HUM) 656 Literature and Arts of the Holocaust 3(3,0) Addresses the Holocaust through literature, art, architecture, music and film. Beginning with historical, political and economic forces that contributed to the Holocaust, course then focuses on highly diverse creative responses to this event—responses that often reflect the difficulties and politics of these commemorative gestures. *Preq:* ENGL 310 or consent of instructor.

ENGL 659 Special Topics in Language, Criticism, Theory 3(3,0) 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 are announced when offered. May be repeated once for credit with department chair's consent. *Preq:* ENGL 310 or consent of instructor.

ENGL 660 Issues in Writing Technologies 3(3,0) Examination of writing technologies from different historical periods. Investigates how writing is understood, circulated, legislated, and protected in terms of its production technology. *Preq:* Sophomore literature; ENGL 211 or consent of instructor.

ENGL 663 Topics in Literature to 1699 3(3,0) Selected readings in literature from antiquity through the 17th century for focused study of authors, movements, themes, critical approaches and genres. Topics vary and are constructed by individual faculty. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* ENGL 310 or consent of instructor.

ENGL 664 Topics in Literature from 1700 to 1899 3(3,0) Selected readings in 18th and 19th century literature for focused study of authors, movements, themes, critical approaches and genres. Special topics vary and are constructed by individual faculty. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* ENGL 310 or consent of instructor.

ENGL 665 Topics in Literature from 1900 3(3,0) Selected readings in 20th and 21st century literature for focused study of authors, movements, themes, critical approaches and genres. Topics vary and are constructed by individual faculty. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* ENGL 310 or consent of instructor.

ENGL 675 Writing for Electronic Media 3(3,0) Workshop in new forms of writing and hypertextual design for interactive electronic media, including social networks, online and video communities. May be repeated once for credit at the undergraduate level. *Preq:* ENGL 310 or consent of instructor.

ENGL 678 Digital Literacy 3(3,0) Examines how technology has expanded ideas of literacies and 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. *Preq:* ENGL 310 or consent of instructor.

ENGL 682 African American Literature to 1920 3(3,0) Critical examination of the development of the African American literary tradition from the Colonial Period to the Harlem Renaissance that considers the historical and cultural contexts of a variety of texts, themes and theories. *Preq:* ENGL 310 or consent of instructor.

ENGL 683 African American Literature from 1920 to the Present 3(3,0) Critical examination of the development of the African American literary tradition from the Harlem Renaissance to the present that considers the historical and cultural contexts of a variety of texts, themes and theories. *Preq:* ENGL 310 or consent of instructor.

ENGL (EDSEC) 685 Composition and Language Studies for Teachers 3(3,0) Examines the principles and practices of composing and teaching composition. Historical study of English language with attention to phonology, morphology, syntax, semantics, practical aspects of language grammars. Practicum in composing and assessing processes, collaborative learning, writers' purposes, audience expectations and language conventions. *Preq:* ENGL 310 or consent of instructor.

ENGL 687 Topics in Book History 3(3,0) Examines the material and theoretical constructions of the book. Covers both historical and contemporary dimensions of dissemination, reception, artistry, and influence of books. *Preq:* ENGL 103.

ENGL 688 Genre and Activity Theory 3(3,0) Examination of the forms that texts take, of the print and digital media in which they are composed and of the ways they circulate among experts, in the public and around the world. *Preq:* Junior standing.

ENGL 689 Special Topics in Writing and Publication Studies 3(3,0) Selected readings from topics in writing and publication studies, emphasizing areas such as major theories, practices, research and critical approaches. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* ENGL 310 or consent of instructor.

ENGL 690 Advanced Technical and Business Writing 3(3,0) Advanced work in writing proposals, manuals, reports, and publishable articles. Client-based and collaborative writing. *Preq:* ENGL 304 or 314 or consent of instructor.

ENGL (COMM) 691 Classical Rhetoric 3(3,0) Traces the development of rhetoric from Protagoras through Isocrates, Plato, Aristotle, Cicero and Quintillian, and considers questions essential to understanding persuasive theory and practices. *Preq:* ENGL 310 or consent of instructor.

ENGL (COMM) 692 Modern Rhetoric 3(3,0) Examines 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. *Preq:* ENGL 310 or consent of instructor.

ENGL 694 Writing About Science 3(3,0) Advanced work in scientific writing and editing for peer and lay audiences. *Preq:* ENGL 310 or consent of instructor.

ENGL 695 Technical Editing 3(3,0) Practical experience in editing and preparing technical manuscripts for publication. General introduction to the functions of the technical editor. *Preq:* ENGL 314 or consent of instructor.

ENGL 698 Writing Center Theory and Practice 3(3,1) Preparation for students to work in the Clemson University Writing Center. Required of all undergraduate writing fellows. *Preq:* Sophomore standing and consent of instructor.

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

ENGL 800 Introduction to Research 1(1,0) 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(3,0) Principal theories and practices in modern grammar, stylistics and semantics related to teaching composition.

ENGL 802 Topics in Literary Genres 3(3,0) Principal literary genres.

ENGL 803 Topics in Rhetorical Theory 3(3,0) Major rhetorical theories, figures and historical movements.

ENGL (COMM) 804 Fundamentals of Health Communication 3(3,0) Fundamentals of health communication and the Health Communication Certificate; two theoretical bases underlying this interdisciplinary program in health communication, one based on social science theory and one based on humanities, i.e. rhetorical theory; history of both theoretical bases. *Preq:* Graduate standing or consent of Health Communication Coordinator.

ENGL 805 Topics in Medieval Literature 3(3,0) Principal works in verse and prose from c. 1100–1500.

ENGL 806 Medical Rhetoric and Writing 3(3,0) Issues in medical writing and health communication, including grant writing and writing for visual and electronic media; general and specific forms and documents for professional writers in health professions. *Preq:* Graduate standing or consent of Health Communication Coordinator.

ENGL (COMM) 807 Health Communication Campaign Planning and Evaluation 3(3,0) Application of theories, practices and tools developed in ENGL 804 and 806 to planning, implementing and evaluating a public health campaign that targets a particular health practice. *Preq:* ENGL 804 and 806 or consent of Health Communication Certificate Coordinator.

ENGL 808 Topics in Renaissance and Restoration Literature 3(3,0) Principal works in verse and prose from c. 1500–1700.

ENGL (COMM) 809 Communication, Culture and the Social Net 3(3,0) See COMM 809.

ENGL 810 Literary Criticism and Theory 3(3,0) Introduces significant methods, approaches and theorists in the current practice of literary and cultural criticism. Establishes a basic familiarity with the vocabulary and techniques of major critical movements and offers a foundation for specialized study.

ENGL 811 Topics in Neoclassic and Romantic Literature 3(3,0) Principal works in verse and prose from c. 1700–1832.

ENGL 814 Topics in Victorian and Modern British Literature 3(3,0) Principal works in verse and prose from c. 1832 to present. May be repeated for a maximum of nine credits.

ENGL 820 Topics in American Literature to 1865 3(3,0) 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(3,0) Significant authors; works in poetry and prose; literary-intellectual movements such as realism, naturalism, modernism and postmodernism from 1865 to the present. May be repeated for a maximum of nine credits.

ENGL 831 Special Topics 3(3,0) Topics not covered in other courses. May be repeated for a maximum of nine credits.

ENGL 832 Topics in Scientific, Technical and Business Writing 3(3,0) Covers topics not covered in other professional communication seminars.

ENGL 833 Rhetoric of Science 3(3,0) Rhetorical approaches to understanding science and scientific rhetorics.

ENGL 834 Usability Testing Methodologies in Professional Communication 3(3,0) Research methodologies used in testing the usability of professional communication.

ENGL 835 Topics in Literary Criticism 3(3,0) Principal statements of literary critics from the classical era to the present.

ENGL 836 Digital Publishing Technologies: Theories in Practice 3(3,0) User-centered design theories applied to multimedia interfaces and on-line documents for professional communicators.

ENGL 838 Global Professional Communication 3(3,0) Implications of professional communication in an international context; theories, methods and practices of global professional communication.

ENGL 839 Writing Proposals and Grant Applications 3(3,0) Practice in reading requests for oral and digital proposals, analyzing rhetorical contexts and theories of proposals, and writing proposals and grant applications; and making oral and digital presentations of proposals.

ENGL (A A H, COMM) 840 Selected Topics 3(3,0) Independent/directed study; tutorial work in linguistics, professional communication, or American, British or European literature not offered in other courses. *Preq:* Consent of director of MA in English or MA in Professional Communication program.

ENGL (COMM) 850 Research Methods in Professional Communication 3(3,0) Covers various research methods with emphasis on humanistic and empirical inquiry. Readings and research examine how professional communication creates new knowledge and affects the daily lives of others.

ENGL 851 Seminar in Professional Writing 3(3,0) Advanced seminar in the principles and practice of writing and editing documents for government, industry and the sciences. Students produce projects suitable for publication or presentation; professional development for technical communicators.

ENGL 852 Rhetoric and Professional Communication 3(3,0) Theories of effective communication, classical to contemporary, that inform decision-making strategies in professional communication.

ENGL 853 Visual Communication 3(3,0) 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; technologies of visual communication; and technologies of visual production.

ENGL 854 Teaching Professional Writing 3(3,0) Examines theories and practices of teaching written, graphic and oral communication. Students prepare course descriptions, rationales and syllabi for teaching various forms of business, scientific and technical writing.

ENGL 856 Theories and Practices of Workplace Communication 3(3,1) Workplace cultures and their theoretical and practical applications for professional communication.

ENGL 860 The Rhetoric of Web Publishing 3(3,0) Seminar in the theory and practice of communicating on the World Wide Web. Focuses on content strategies for large-scale Web site deployment, and examines taxonomies of Web page types and patterns of user experience interactions. *Prerequisite:* ENGL 853.

ENGL 872 Print and Digital Portfolios 3(3,0) Focuses on theories, development, construction and assessment of print and digital portfolios in educational contexts including the classroom, school reform and other large-scale efforts, programmatic assessments and personal/professional development. Special attention is given to ways the medium shapes reflection, presentation, connections and artifacts within the portfolio.

ENGL 885 Composition Theory 3(3,0) Teaching college-level courses, stressing contemporary composition theory, research and practice. Required of all MA in English and MAPC Teaching Assistants.

ENGL 886 Composition Practicum 1(1,0) Students continue training for teaching ENGL 103, Accelerated Composition. Specific attention is given to translating theoretical concepts into creating assignments, designing curriculum and grading. Course is to be taken only fall semester of student's teaching assistantship year. No credit towards a degree will be awarded. *Prerequisite:* Graduate teaching assistantship and ENGL 885 or equivalent.

ENGL 887 Writing Center Theory and Practice 1(1,0) Prepares graduate students in English and Professional Communication Programs to work with students in the Writing Center. *Prerequisite:* Graduate standing or consent of instructor.

ENGL 891 Master's Thesis Research 1-12

ENGL 892 Master's Project 3(3,0) Required for non-thesis option in the Professional Communication MA program. Students create a communication deliverable for the professional world, keep a journal as a record of the project, and write a scholarly paper. Students present projects to their advisor.

ENTOMOLOGY

ENT (BIOSC) 600 Insect Morphology 4(3,3) Study of insect structure in relation to function and of the variation of form in insects. Offered fall semester of even-numbered years only. *Prerequisite:* ENT 301.

ENT 604 Urban Entomology 3(3,0) Study of pests common to the urban environment with emphasis on arthropod pest biology, pest importance and management strategies. Students learn both theoretical and practical aspects of urban pest management. *Prerequisite:* BIOL 103 and 104, or 110 and 111, or ENT 301, or consent of instructor.

ENT (PL PA) 606 Diseases and Insects of Turfgrasses 2(2,0) See PL PA 606.

ENT 607 Applied Agricultural Entomology 4(3,3)

Topics include 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 are introduced. Offered fall semester of even-numbered years only. *Prerequisite:* ENT 301 or equivalent.

ENT (PL PA) 608 Diseases and Insects of Turfgrasses Laboratory 1(0,3) See PL PA 608.

ENT 609 Urban Entomology Laboratory 1(0,3)

Identification of household and structural pests common to the urban environment. Students also gain hands-on experience in termite and general pest control. *Prerequisite:* BIOL 103 and 104, or 110 and 111, or ENT 301, or consent of instructor; concurrent enrollment in ENT 604.

ENT (BIOSC) 615 Insect Taxonomy 3(1,6)

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. Offered spring semester of odd-numbered years only. *Prerequisite:* ENT (BIOSC) 400 or consent of instructor.

ENT (BIOSC) 636 Insect Behavior 3(2,3)

Fundamentals of insect behavior in an evolutionary and ecological perspective. Laboratory emphasizes generation and testing of hypotheses and observation, description and quantification of insect behavior. Offered fall semester of odd-numbered years only. *Prerequisite:* ENT 301 or consent of instructor.

ENT (BIOSC, W F B) 669 Aquatic Insects 3(1,6)

Identification, life history, habitats and interrelationships of aquatic insects; techniques of qualitative field collecting; important literature and research workers. Offered spring semester of odd-numbered years only. *Prerequisite:* ENT 301 or consent of instructor.

ENT (GEN) 695 Insect Biotechnology 3(3,0)

Considers many unique features exhibited by insects and describes applications of biotechnology to enhance useful products from insects and to affect the control of destructive insects. *Prerequisite:* ENT 301, GEN 302.

ENT 700 Entomology for Teachers 3(2,2)

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 MS or PhD degrees. Offered spring semester only. *Prerequisite:* Consent of instructor.

ENT 808 Taxonomy of Immature Insects 3(1,6)

Identification of immature insects emphasizing the Holometabola. Identified collection is required. Offered fall semester of odd-numbered years only.

ENT 809 Seminar in Entomology 1(1,0)

Current literature and research in entomology. Class attendance is mandatory. May be repeated for credit. To be taken Pass/Fail only.

ENT 810 Selected Topics 1-4(1-4,0) Current areas of entomological research and pest management. May be repeated for credit. *Prerequisite:* Consent of instructor.

ENT 853 Applied Systematics 3(2,3) Application of evolutionary principles to resolution of contemporary zoological problems; legal issues and technical skills for efficient operation of international zoological information storage and retrieval system. Offered spring semester of even-numbered years only. *Prerequisite:* Taxonomic course in entomology or zoology or consent of instructor.

ENT 863 Special Problems in Entomology 1-3(0,3-9) Entomological research not related to thesis. *Prerequisite:* Consent of instructor.

ENT 870 Insect Physiology and Molecular Biology 4(3,3) 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. Laboratory emphasizes hands-on experimentation and the scientific writing technique to report experimental findings. *Prerequisite:* BIOL 111, CH 223, ENT 301, 495, or consent of instructor.

ENT 891 Master's Thesis Research 1-12

ENT 991 Doctoral Dissertation Research 1-12

ENVIRONMENTAL AND NATURAL RESOURCES

E N R (BIOSC) 613 Restoration Ecology 3(3,0) Applies ecological principles to the restoration of disturbed terrestrial, wetland and aquatic ecosystems. Includes the restoration of soils and waterways, of flora and fauna and of natural ecological processes such as plant succession and nutrient cycling. *Prerequisite:* Introductory course in ecology or conservation biology, consent of instructor.

E N R (FOR) 616 Forest Policy and Administration 3(3,0) See FOR 616.

E N R 629 Environmental Law and Policy 3(3,0)

Develops an understanding of the three branches of government that affect and dictate use and protection of natural resources. Attention is given to major federal environmental statutes. Includes examination of how policy is developed, implemented and evaluated in the public and private sectors. *Prerequisite:* Junior standing or consent of instructor.

E N R (FOR) 634 Geographic Information Systems for Landscape Planning 3(2,3) See FOR 634.

E N R 650 Conservation Issues 3(3,0) Interactive study and discussion of issues related to the conservation of natural resources, emphasizing current issues in the conservation of biodiversity, identification of conflicting issues between consumptive and nonconsumptive resource management, and development of viable solutions for conservation of resources. *Prerequisite:* W F B (BIOSC) 313 or consent of instructor.

ENVIRONMENTAL ENGINEERING AND SCIENCE

EE&S 601 Environmental Engineering 3(3,0) Introduction to the field of environmental engineering. Topics include environmental phenomena, impact of pollutants in the aquatic environment, solid-waste management, air pollution control, radiological health and simple water and wastewater treatment systems. *Preq:* Junior standing in engineering or consent of instructor. *Coreq:* C E 341, CH E 230, M E 308 or consent of instructor.

EE&S 602 Water and Waste Water Treatment Systems 3(3,0) Study of fundamental principles, rational design considerations and operational procedures of the unit operations and processes employed in water and waste water treatment. Both physiochemical and biological treatment techniques are discussed. Introduction to the integration of unit operations and processes into water and waste treatment systems. *Preq:* EE&S 202 or 401; or consent of instructor.

EE&S 610 Environmental Radiation Protection 3(3,0) Fundamental principles of radiological health and radiation safety. Topics include radiation fundamentals, basic concepts of environmental radiation protection, internal and external dosimetry, environmental dose calculations and radiation protection standards. Offered fall semester only. *Preq:* Consent of instructor.

EE&S 611 Ionizing Radiation Detection and Measurement 3(2,3) Laboratory exercises in ionizing radiation detection and measurements. Topics include nuclear electronics; counting statistics; radiation interactions; basic gas, scintillation and semiconductor detectors; gamma-ray spectroscopy; health physics survey instrumentation; and thermoluminescent dosimetry. Offered spring semester only. *Preq:* EE&S 410 or consent of instructor.

EE&S 630 Air Pollution Engineering 3(3,0) Introductory course in air pollution and its control. Topics include air pollutants and effects, sources, dispersion models, engineering controls and air-quality legislation. *Preq:* EE&S 202 or senior standing in engineering or physical sciences or consent of instructor.

EE&S (B E, FOR) 651 Newman Seminar and Lecture Series in Natural Resources Engineering 1(0,2) See B E 651.

EE&S 680 Environmental Risk Assessment 3(3,0) Quantitative estimation of the human health risk posed by the release of a contaminant to the environment. Topics include methods for analyzing emission rate, environmental transport, exposure and health effects; methods of uncertainty analysis; and the role of risk assessment in environmental regulation and environmental decision making. *Preq:* EE&S 202 or 401 or consent of instructor.

EE&S (B E) 684 Municipal Solid Waste Management 3(3,0) Introduction to the problems, regulations, collection, handling, recycling and disposal of municipal solid wastes in the urban and rural sectors. Emphasis is on integrated waste-management systems with resource recovery, composting, incineration, landfill disposals and their costs. *Preq:* EE&S 202 or senior standing in engineering or science or consent of instructor.

EE&S 685 Hazardous Waste Management 3(3,0) Introduction to problems, regulations, treatment and ultimate disposal of hazardous and toxic materials. Spill cleanup, groundwater transport, land disposal, incineration and treatment technologies are discussed. Offered spring semester only. *Preq:* EE&S 202 or 401 or consent of instructor; one semester of general chemistry.

EE&S 686 Pollution Prevention and Industrial Ecology 3(3,0) Topics include pollution prevention technology, the role of pollution prevention within a corporation, source reduction and recycling, pollution prevention assessments, treatment to reduce disposal, life-cycle assessment, design for environment, industrial ecology. Emphasis is on case studies. *Preq:* Junior standing in College of Engineering and Science; or consent of instructor.

EE&S 690 Special Projects 1-3(1-3,0) Studies or laboratory investigations on special topics in the environmental engineering and science field. Arranged on a project basis with a maximum of individual student effort and a minimum of staff guidance. May be repeated for a maximum of three credits. *Preq:* Consent of instructor.

EE&S 701 Special Problems 1-6(1-6,0) Environmental engineering problems selected to meet the interests and experience of students and instructor. Formal report is required. Restricted to MEngr students. To be taken Pass/Fail only.

EE&S 802 Environmental Engineering Principles 3(3,0) Fundamental principles required for simulation and modeling of environmental engineering phenomena; mass transfer, reactor kinetics, simulation techniques and applications to various natural and engineered systems. Offered fall semester only.

EE&S 803 Physicochemical Operations in Water and Wastewater Treatment Systems 3(3,0) Principles of physicochemical operations used in water and wastewater treatment including sedimentation, filtration, mixing, gas transfer, adsorption, ion exchange, coagulation, precipitation, disinfection and oxidation. Offered spring semester only. *Preq:* EE&S 802, 843.

EE&S 804 Biochemical Operations in Wastewater Treatment Systems 3(3,0) Principles of biochemical operations used in wastewater treatment; modeling of ideal biochemical reactors and design criteria for aerated lagoons, activated sludge, trickling filters, rotating biological contactors, nitrification, denitrification and digestion. Offered spring semester only. *Preq:* EE&S 802, 851.

EE&S 805 Laboratory in Water and Wastewater Treatment Operations 3(0,6) Laboratory exercises in selected water and wastewater treatment operations including sedimentation, filtration, adsorption, coagulation, softening, aeration, activated sludge, aerobic digestion and anaerobic digestion. Offered spring semester only. *Coreq:* EE&S 803 or 804.

EE&S 806 Process and Facility Design for Environmental Control Systems 2-4(2-4,0) 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. Student teams design an integrated system for either water/wastewater or a hazardous/toxic waste. Offered fall semester only. *Preq:* EE&S 803, 804.

EE&S (GEOL) 808 Groundwater Modeling 3(3,0) See GEOL 808.

EE&S (GEOL) 809 Subsurface Remediation Modeling 3(3,0) See GEOL 809.

EE&S (GEOL) 810 Analytical Methods for Hydrogeology 3(3,0) See GEOL 810.

EE&S 812 Environmental Nuclear Engineering 3(3,0) Environmental aspects of nuclear technology emphasizing nuclear reactors and the nuclear fuel cycle; environmental transport of radioactive materials; radioactive effluents from nuclear power plants; nuclear power plant safety; environmental aspects of fuel cycle activities; waste management. Offered fall semester only. *Preq:* EE&S 610, consent of instructor.

EE&S 813 Environmental Radiation Protection Laboratory 3(1,6) Continuation of EE&S 611; advanced experiments in radiation detection, radiation protection, health physics and environmental monitoring. Offered fall semester only. *Preq:* EE&S 611 and consent of instructor.

EE&S (CH E) 814 Applied Numerical Methods in Process Simulation 3(3,0) See CH E 814.

EE&S 816 Technical Nuclear Forensics 3(3,0) Technical nuclear forensics is a discipline that involves the collection, analysis and evaluation of samples from pre-detonation or post-detonation of a nuclear weapon. These radiological and nuclear materials, as well as devices, debris, and immediate effects created by a nuclear detonation, are studied. *Preq:* EE&S 610 or consent of instructor.

EE&S 820 Environmental Systems Analysis 3(3,0) Analysis of a systems view of environmental problems, with particular emphasis on conflicting objectives such as economic and environmental concerns. Example problems span traditional environmental engineering processes, natural resources, proactive environmental management and sustainability. *Preq:* MTHSC 311 or consent of instructor.

EE&S 832 Air Pollution Meteorology 3(3,0) Applications of meteorology to air pollution; micro-meteorology; plume rise modeling; atmospheric diffusion; deposition and washout of pollutants; air chemistry; applications of diffusion modeling to air quality planning. *Preq:* Consent of instructor.

EE&S 833 Air Pollution Control Systems 3(3,0) Principles and design of air pollution control equipment including mechanical collectors, electrostatic precipitators, baghouse filters, wet scrubbers, adsorbers and incinerators. Offered spring semester only. *Preq:* EE&S 430 or consent of instructor.

EE&S 834 Particles in the Atmosphere 3(3,0) Chemical and physical behavior of atmospheric particles and their interaction with other particles, gases and light; generation, measurement methods and control strategies of atmospheric particles. *Preq:* EE&S 630, MTHSC 208, or consent of instructor.

EE&S 837 Biodegradation and Bioremediation 3(3,0) 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. *Preq:* EE&S 851.

EE&S (CH) 842 Actinide Chemistry 3(3,0) Chemical and physical aspects of actinide metals and compounds (including properties, structure and bonding, reactions, kinetics, thermodynamics), coordination and solution chemistry, behavior and speciation in the environment, separation and purification, chemistry of the nuclear fuel cycle and waste treatment and related topics; fundamental concepts, history and recent developments. *Preq:* CH 402, MTHSC 208, PHYS 221, or consent of instructor.

EE&S 843 Environmental Chemistry 3(3,0) 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. Offered fall semester only. *Preq:* CH 102 or equivalent.

EE&S 844 Environmental Chemistry Laboratory I 3(2,3) 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. Offered fall semester only. *Preq:* Two semesters of general chemistry.

EE&S 845 Environmental Organic Chemistry 3(3,0) 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. Offered spring semester only. *Preq:* Two semesters of general chemistry, EE&S 843 or equivalent.

EE&S 847 Advanced Environmental Chemistry 3(3,0) Advanced principles and methods in environmental engineering chemistry with applications to both natural and treatment systems; current investigative and study techniques; nature, fluxes and controlling processes of chemical species and radionuclides in environmental systems. *Preq:* EE&S 843 or equivalent.

EE&S 849 Environmental Chemistry Laboratory II 3(1,6) 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. Offered fall semester only.

EE&S 850 Stream and Estuarine Analysis 3(3,0) 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. Offered fall semester only.

EE&S 851 Biological Principles of Environmental Engineering 3(3,0) Basic principles of biology and biochemistry as applied to problems of environ-

mental control and wastewater treatment; kinetic and energetic aspects. Offered fall semester only.

EE&S 852 Subsurface and Wetland Hydraulics 3(3,0) 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. *Preq:* Differential equations, fluid mechanics or EE&S 802 or consent of instructor.

EE&S 855 Surface and Subsurface Transport 3(3,0) 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. *Preq:* C E 340 and MTHSC 208 or equivalent.

EE&S 856 Pollution of the Aquatic Environment 3(3,0) 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. Offered fall semester only.

EE&S 861 Environmental Engineering and Science Seminar 1(1,0) Current advances and research developments in various areas of environmental engineering and science. Off-campus speakers, students and faculty participate. To be taken Pass/Fail only.

EE&S 880 Environmental Risk Assessment 3(3,0) 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. Offered spring semester only. *Preq:* MTHSC 208, graduate standing in engineering or science.

EE&S 881 Special Problems 1-4 Problems selected to meet interests and experiences of student and instructor.

EE&S 883 Selected Topics in Environmental Engineering 1-4(1-4,0) Topics in environmental engineering not covered in other courses. Topics vary 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(1-4,0) Topics in environmental engineering not covered in other courses. Topics vary 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 1-12

EE&S 961 Environmental Engineering and Science Doctoral Student Seminar 1(1,0) Current advances and research developments in various areas of environmental engineering and science. Doctoral students are required to enroll each semester that the course is offered and present one seminar per year. To be taken Pass/Fail only.

EE&S 991 Doctoral Dissertation Research 1-12

ENVIRONMENTAL SCIENCE AND POLICY

EN SP 672 Environmental Planning and Control 2(2,0) 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 are considered from the standpoint of control. Not intended for graduate students in engineering. *Preq:* Consent of instructor.

ENVIRONMENTAL TOXICOLOGY

ENTOX 600 Wildlife Toxicology 3(3,0) 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 are discussed. *Preq:* BIOCH 305 or organic chemistry, one year of general biology, W F B 350 or consent of instructor.

ENTOX 621 Chemical Sources and Fate in Environmental Systems 3(3,0) Chemical cycles in the environment are discussed on global and microcosm scales. The dependence of fate processes on physical and chemical properties and environmental conditions is examined. Breakdown, movement and transport of selected toxicants are addressed to illustrate the mechanisms that govern chemical fate. *Preq:* Organic and analytical chemistry or consent of instructor.

ENTOX (ENT) 630 Toxicology 3(3,0) Basic principles of toxicology including quantitation of toxicity, toxicokinetics, biochemical action of poisons and environmental toxicology are studied. Acute and chronic effects of various classes of poisons are discussed (e.g., pesticides, drugs, metals and industrial pollutants) in relation to typical routes of exposure and regulatory testing methods. Offered fall semester of odd-numbered years only. *Preq:* Organic chemistry, one year of general biology, or consent of instructor.

ENTOX 637 Ecotoxicology 3(3,0) Study of the effects of stressors on the ecosystem. Explores the integrative relationships that comprise the field of ecotoxicology in a hierarchical format that focuses on the various levels of ecological organization. *Preq:* ENTOX 430 or consent of instructor.

ENTOX (CSENV, GEOL) 685 Environmental Soil Chemistry 3(3,0) See CSENV 685.

ENTOX (BIOSC) 811 Immunotoxicology 3(3,0) Study of how environmental contaminants, drugs and natural biotoxins affect the immune system of man and animals; cellular and molecular mechanisms of action by immunotoxic agents. *Preq:* AVS 825, ENTOX 630, consent of instructor.

ENTOX 822 Analytical Toxicology Laboratory 3(1,6) 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. *Preq:* Organic and analytical chemistry or consent of instructor; instrumental analysis recommended.

ENTOX (BIOSC) 830 Mechanistic Toxicology 3(3,0) 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 (ENT) 430.

ENTOX (BIOSC) 831 Biomarkers in Toxicology 3(1,6) Methodology used in biomarker identification and evaluation of the effects of toxic substances on living systems using biomarkers in sentinel organisms and surrogate biomarkers. *Prerequisite:* Organic chemistry and biochemistry with laboratory; ENTOX 400 or (ENT) 430; or consent of instructor.

ENTOX 841 Procedures and Techniques in Ecological Risk Assessment 2(1,3) 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. *Prerequisite:* CH 223, 224, 313; EX ST 804 or 805; ENTOX (ENT) 630; or consent of instructor.

ENTOX 852 Ecological Models 3(2,3) 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:* Course in ecology and in computer programming or consent of instructor.

ENTOX (BIOSC) 854 Aquatic Toxicology 3(3,0) Combines concepts of solution chemistry with toxicology to establish stressor-response relationships for aquatic organisms at various trophic levels. Bioavailability is a unifying concept and concepts of contaminant exposure and organism response are set in an ecological risk assessment framework.

ENTOX 855 Sediment Toxicology and Chemistry 3(3,0) Focuses on the chemistry and toxicology of contaminants in freshwater sediments. Sediment geochemistry, ecology, toxicity bioassay methodology and sediment sampling are discussed in a course framework that deals directly with contaminant bioavailability questions. *Prerequisite:* ENTOX 854 or consent of instructor.

ENTOX 860 Graduate Seminar 1(1,0) 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. To be taken Pass/Fail only.

ENTOX 861 Departmental Seminar 1(1,0) Presents current research by Department of Environmental Toxicology faculty, staff, finishing graduate students and invited speakers. Improves students' skills in evaluation of research plans and oral presentations and increases their awareness of literature resources and employment opportunities in the field. May be repeated four times for credit.

ENTOX 863 Selected Topics 1-4(0-4,0-6) Topics in environmental toxicology not covered in other courses. Topics vary with current developments in the discipline. May be repeated, but only if different topics are covered. *Prerequisite:* Consent of instructor.

ENTOX 891 Master's Thesis Research 1-12

ENTOX 991 Doctoral Dissertation Research 1-12

EXECUTIVE LEADERSHIP AND ENTREPRENEURSHIP

E L E 600 Technology Entrepreneurship 3(3,0)

Introduction to technology entrepreneurship with emphasis on ideation, opportunity assessment, market and technology forecasting, intellectual property protection, financial modeling and business valuation, project management and cross-functional team building. Open to science and engineering majors only. *Prerequisite:* Junior standing.

E L E 800 Special Topics in Technology Entrepreneurship 1-6(1-6,0)

Comprehensive study of a topic of current interest in technology entrepreneurship. May be repeated for a maximum of six credits, but only if different topics are covered. *Prerequisite:* E L E 400.

EXPERIMENTAL STATISTICS

EX ST 602 Introduction to Statistical Computing 3(3,0)

Introduction to statistical computing packages. Topics include data importation, basic descriptive statistic computation, basic graphic preparation, and statistical analysis methods and procedures. *Prerequisite:* EX ST 301.

EX ST 611 Statistical Methods for Process Development and Control 3(3,0) 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. Includes discussions of the use of statistical computer analyses and interpretations including computer-generated graphics. *Prerequisite:* MTHSC 206 or consent of instructor.

EX ST 801 Statistical Methods I 4(3,3) 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:* Consent of instructor.

EX ST 802 Statistical Methods II 3(3,0) 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(3,0)

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. Offered spring semester only. *Prerequisite:* EX ST 801.

EX ST 804 Sampling 3(3,0) Principles of scientific sampling; finite population sampling; simple random, stratified, multistage and systematic sampling; optimum allocation; methods of obtaining, processing and reporting survey information; sampling as related to the environment, natural resources and social and economic problems. *Prerequisite:* EX ST 801.

EX ST 805 Design and Analysis of Experiments 3(3,0)

Basic designs and analysis; data transformations; single degree of freedom, orthogonality and responses in ANOVA; covariance; response surfaces; incomplete blocks; introduction to least squares analysis of experiments; uses of standard computer programs for selected analyses. *Prerequisite:* EX ST 801.

EX ST 811 Special Problems in Experimental Statistics 1-3(0,2-6) 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(1-3,0) Topics in applied statistics not covered in other courses. May be repeated, but only if different topics are covered.

EX ST 815 Environmental and Ecological Statistics 3(3,0)

Overview of statistical techniques in Environmental Science and Ecology. Probability distributions and sampling; population estimation using capture/recapture, line transect and line intercept methods; spatial point pattern analysis; modelling environmental and ecological data; environmental monitoring. *Prerequisite:* EX ST 801 and 803 or consent of instructor.

EX ST 816 Spatial Statistics 3(3,0) Introduction to spatial data analysis emphasizing concepts and interpretation, spatial point processes, clustering, spatial autocorrelation, semivariograms, kriging, spatial regression and analysis of variance. *Prerequisite:* EX ST 801 and 803 or consent of instructor.

EX ST 817 Multivariate Statistics in Agriculture, Forestry and Natural Resources 3(3,0) Application of multivariate techniques for linear models (MANOVA, Hotellings T₂), covariance structure (principal components, factor analysis), classification (discriminant and cluster analyses) and structural equation modeling drawing examples from life sciences, natural resources, tourism and related programs. *Prerequisite:* EX ST 801 and 803 or consent of instructor.

EX ST 819 Biostatistics 3(3,0) Statistical analyses applicable to disease/mortality occurrence. Introduction to epidemiology study designs and appropriate statistical analyses. Statistical methodology applicable to life-tables and survival curves and clinical trials. *Prerequisite:* EX ST 801.

FAMILY AND COMMUNITY STUDIES

FCS 810 Life in the Global Community 3(3,0) Examines global perspectives and trends related to social, psychological and physical well being of children, youth, adults, families, primary institutions of society and civil society. Considers accommodation and resistance to globalization as well as analysis and comparative review of the effects of globalization on everyday life in selected countries.

FCS 811 Human Development and Family Life in Cultural Context 3(3,0) Examines cultural context in human development and family life; the impacts of culture on physical, cognitive and social development; the influences of different environmental experiences on individual and family functioning; practical applications of a cross-cultural human and family development perspective; and the state of human development around the world. *Preq:* FCS 810.

FCS 812 Democracy and the Growth of Civil Society 3(3,0) Study of democracy as a political system and a way of life. Examines the nature of civil society and its relation to the development and sustainability of democratic values and institutions and the cultural, economic and political correlates of civic participation at various points in the lifespan. *Preq:* FCS 810 or consent of instructor.

FCS 820 International Human Rights Law 3(3,0) Examines international human rights law, the origins of international human rights, the emergence of international human rights law, issues related to the implementation, the position of the U.S. regarding ratification of human rights treaties, processes for monitoring and implementing human rights and treatment of human rights in the courts.

FCS (P ADM) 827 Public Personnel Administration 3(3,0) See P ADM 827.

FCS (P ADM) 829 Public Financial Management 3(3,0) See P ADM 829.

FCS 830 Community Development: Principles and Practices 3(3,0) Comparative theory and practice of community development, community building and community transformations that support child, youth and family well-being. Includes U.S. community development examples with selected examples from other nations.

FCS 831 Community Transformation 3(3,0) Advanced course on community transformation theories, theologies and practice. Discusses and illustrates major paradigm shifts within the last three decades in the way community development is thought about and done. Case studies on community transformation from selected nations are utilized. *Preq:* FCS 830 or consent of instructor.

FCS 832 Policies and Programs in Human Services 3(3,0) Philosophy, theories and principles for organizing human services in and across selected nations, emphasizing strategies for and barriers to the development of collaborations among and between governmental and nongovernmental organizations. Discusses community-level child and family support, poverty alleviation, health care, early childhood education care and old-age assistance. *Preq:* FCS 830 or consent of instructor.

FCS 833 Humanitarian Assistance 3(3,0) Introduction to humanitarian assistance. Topics include historical background, current status, determinants, legal issues, and health and social service delivery to current and past refugee and internally-displaced people, and ethnopolitical conflicts and terrorism as major sources of humanitarian crises. *Preq:* FCS 830 or consent of instructor.

FCS 835 Institutions in Community Life 3(3,0) Interdisciplinary review of core community institutions and their impact on families and communities. Focuses on four institutions: education, religion, health and government. Each institution is examined both individually and from a systems perspective for its relationship with other institutions and with families and communities.

FCS 836 Area Studies 3(3,0) Expands students' knowledge of the nature of family and community life in various regions of the world (e.g., Eastern Europe; Middle East; Latin America; the Caribbean). Topics include political, social and economic trends; social and political transformation; cross cultural issues; globalization; human rights; and civil society. May be repeated for a maximum of six credits.

FCS 840 Topics in Societal and International Research 1-3(1-3,0) Covers selected topics in research design and data analysis with attention to community-based and field research, and research in international settings. *Preq:* Consent of instructor.

FCS 851 International Law and Policy on Children's Issues 3(3,0) Comparative analysis of law and policy on children's issues. Attention is given to relevant international instruments, particularly the Convention on the Rights of the Child and to related concepts in the law and policy of various nations, including the United States. *Preq:* FCS 820.

FCS 852 Right to Health 3(3,0) Examination of the relationship between health and human rights emphasizing the application of a rights-based approach to health-related interests of children, families and communities. Topics include discussion of the content and contours of a right to health and of emerging trends in health and human rights. *Preq:* FCS 820 or consent of instructor.

FCS (P ADM) 862 Administrative Leadership 3(3,0) See P ADM 862.

FCS (P ADM) 878 Selected Topics in Public Administration 3(3,0) See P ADM 878.

FCS 890 Research Project 1-6 Research in Family and Community Studies not related to a thesis.

FCS 892 Special Topics 1-3(1-3,0) Selected current and classic topics not covered in other courses. May be repeated for a maximum of 12 credits, but only if different topics are covered.

FCS 893 Practicum 1-6 Students synthesize, integrate and apply knowledge and skills learned through courses to family and community issues, working with faculty and community leaders to gain professional experience. To be taken Pass/Fail only. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.

FCS 896 Independent Study 1-6(1-6,0) Individual readings or research on a topics selected according to the student's interests or professional development needs. May be repeated for a maximum of six credits. To be taken Pass/Fail only. *Preq:* Consent of coordinator of graduate studies.

FCS 991 Doctoral Research 1-18

FINANCE

FIN 602 Advanced Corporate Finance 3(3,0) Study of the decision process and analytical techniques used in evaluating corporate investment and financing decisions. Topics include capital budgeting, capital structure and bankruptcy, valuation, corporate governance, executive compensation, mergers and acquisitions, and restructuring. *Preq:* FIN 312 with a C or better.

FIN 606 Analysis and Use of Derivatives 3(3,0) Consideration of the option pricing theory and strategy techniques most commonly used in the market for options. An overview of the futures markets is also considered. Special emphasis is given to interest-rate futures, stock-index futures and foreign-exchange futures. *Preq:* FIN 305 with a C or better.

FIN 615 Real Estate Investment 3(3,0) Focuses on the 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. *Preq:* FIN 307 with a C or better.

FIN 616 Real Estate Valuation 3(3,0) Advanced course in commercial real estate valuation. Topics include income capitalization, cash equivalency, highest and best use analysis, the cost approach, the direct sales comparison approach and DCF analysis. *Preq:* FIN 307 with a C or better.

FIN 617 Real Estate Finance 3(3,0) Advanced course applying financial analysis and theory to real estate. Mortgage credit analysis and current financing techniques for residential and commercial properties are emphasized. Topics include financial institutions, syndications and construction financing. *Preq:* FIN 307 with a C or better.

FIN (M B A) 832 International Financial Management 3(3,0) See M B A 832.

FIN (M B A) 836 Real Estate Principles 3(3,0) See M B A 836.

FOOD SCIENCE

FD SC 601 Food Chemistry I 3(3,0) Basic composition, structure and properties of food and the chemistry of changes occurring during processing utilization. Offered fall semester of even-numbered years only. *Preq:* BIOCH 305 or consent of instructor.

FD SC 602 Food Chemistry II 3(3,0) 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 are examined. Offered spring semester of odd-numbered years only. *Preq:* BIOCH 305 or consent of instructor.

FD SC 603 Food Chemistry and Analysis 2(1,3) Principles of analytical procedures and techniques used to quantitatively and qualitatively determine chemical composition of foods, and elucidate the physio-chemical properties of food materials. Laboratories provide experience in critical thinking, performing food analysis, and analyzing data. *Preq:* BIOCH 305, BIOSC 434, or consent of instructor.

FD SC 604 Food Preservation and Processing 3(3,0)

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. *Preq:* Physics and organic chemistry or biochemistry.

FD SC 606 Food Preservation and Processing Laboratory 1(0,3)

Laboratory exercises on preservation methods, equipment utilized and processes followed in food manufacture. *Coreq:* FD SC 404.

FD SC 607 Quantity Food Production 2(1,3)

Principles of the production of food in quantity for use in food service systems, Emphasis is on functions of components of foods and of ingredients in food, on the quality of the final product, on safe production of food and on proper use of equipment. *Coreq:* FD SC 306, 404.

FD SC 608 Food Process Engineering 4(3,3)

Study of basic engineering principles and their application in food processing operations. The relation between engineering principles and fundamentals of food processing is emphasized. *Preq:* FD SC 214, CH 102, MTHSC 106, PHYS 207 or 200 or 122 or consent of instructor.

FD SC 610 Food Product Development 4(3,3)

A strategic and systems approach to integrated product development practices for developing new food products within a team setting. Focuses on the Stage-Gate process for moving from product idea to launch and application of sensory analysis techniques.

FD SC 630 Dairy Processing and Sanitation 3(2,3)

Processing, manufacture and distribution of fluid, frozen, cultured and other dairy products. Emphasizes sanitation in a commercial food processing plant environment, chemical and microbiological aspects, processing procedures, equipment operation, ingredient applications, formulation and functional properties. *Preq:* BIOL 104/106, CH 102.

FD SC 802 Nutraceuticals and Functional Food 2(2,0)

Students identify sources, formulations, functional properties, and processing regulations for nutraceuticals and functional foods, and review the chemistry of separation and identification of bioactive ingredients. *Preq:* FD SC 601 and 602.

FD SC 810 Chemical and Biochemical Aspects of Foods 4(4,0)

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. *Preq:* BIOCH 623 and FD SC 401 or consent of instructor.

FD SC 811 Physical and Thermophysical Properties of Foods 3(3,0)

Principles involved in relating physical and thermophysical properties to food quality. Includes 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. *Preq:* FD SC 810 or consent of instructor.

FD SC 812 Microbiological Aspects of Food Systems 3(3,0)

Function and characteristics of microorganisms in the utilization and manufacture of food products; food fermentations, microbially induced chemical and physical changes, environmental aspects, and production of food ingredients and resources. *Preq:* MICRO 407 or equivalent or consent of instructor.

FD SC 815 Food Service Systems Management 4(3,3)

Management of the procurement, production, distribution and service of food that meets nutrition guidelines, cost parameters and consumer acceptance criteria; supervision of customer satisfaction systems, marketing functions and human resource systems.

FD SC 820 Selected Topics in Food Science 1-3(1-3,0)

Special topics in food science not covered in other courses. May be repeated for a maximum of nine credits.

FD SC 821 Selected Topics 1-4(0,3-12)

Independent research investigation in food science areas not conducted in other courses. May be repeated for a maximum of 12 credits. *Preq:* Consent of instructor.

FD SC 851 Food Science Seminar 1(1,0)

Current research and related developments in food science reviewed by faculty, students and invited lecturers. May be repeated for a maximum of two credits, but only if different topics are covered.

FD SC 855 Practicum Teaching Experience 1(1,0)

Students integrate and apply knowledge and skills in assisting a faculty member in the teaching of an undergraduate lecture or laboratory course in food, nutrition, and/or packaging science.

FD SC 891 Master's Thesis Research 1-12**FOOD TECHNOLOGY****FD TH 851 Food Technology Seminar 1(1,0)**

Current and ongoing research and developments in food technology reviewed by faculty, students and invited lecturers. *Preq:* Enrollment in the Food Technology PhD program or consent of instructor.

FD TH 991 Doctoral Dissertation Research 1-12**FORESTRY****FOR 600 Public Relations in Natural Resources 3(3,0)**

Identifying relevant policies, their characteristics and acceptance to natural resource management and techniques of maintaining appropriate public relations. *Preq:* Senior standing.

FOR 608 Wood and Paper Products 3(3,0)

Study of wood structures and identification; physical and mechanical properties of wood products; standard testing procedures; manufacture of lumber, plywood, oriented strand board; drying, preservation, grading and use of wood products. Also discusses common grades of paper and paperboard; fiber sources; pulping and paper-making equipment and processes; chemical recovery process; and environmental issues. *Preq:* Junior standing or consent of instructor.

FOR 610 Harvesting Processes 4(3,3)

Study of forest harvesting processes with detailed analysis of production, cost, environmental impacts, safety, transportation and business considerations. *Preq:* Senior standing or consent of instructor.

FOR 613 Integrated Forest Pest Management 4(3,3)

Nature and control of pests of forest trees and products. Focuses on the relation of pests to silviculture, management and natural forest ecosystems. Offered fall semester only. *Preq:* Junior standing in Forest Resource Management.

FOR 615 Forest Wildlife Management 3(2,3)

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 is evaluated. *Preq:* FOR 460 or consent of instructor.

FOR (ENR) 616 Forest Policy and Administration 3(3,0)

Introduction to development, principles and legal provisions of forest policy in the United States and an examination of administrative and executive management in forestry.

FOR 617 Forest Resource Management and Regulation 3(3,0)

Fundamental principles and analytical techniques in planning, management and optimization of forest operations. *Preq:* FOR 302, 308, 418, 465.

FOR 618 Forest Resource Valuation 3(3,0)

Analysis of 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. *Preq:* FOR 304 or consent of instructor.

FOR 623 Current Issues in Natural Resources 2(2,0)

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. Offered fall semester only. *Preq:* Junior standing or consent of instructor.

FOR (HORT) 627 Urban Tree Care 3(3,0)

Principles, practices and problems of protecting and maintaining trees in urban and recreational areas. Examines environmental and biological factors affecting trees in high-use areas, their management and cultural requirements and the practices necessary for their protection and care as valuable assets in the landscape. *Preq:* Consent of instructor.

FOR 631 Recreation Resource Planning in Forest Management 2(1,3)

Analysis of forest recreation as a component of multiple-use forest management; techniques of planning; physical and biological effects on forest environments; and forest site, user and facility management. Offered spring semester of odd-numbered years only.

FOR 633 GPS Applications 3(2,3)

Develops competence in global positioning system (GPS) technology including theory, methods and application to natural resources mapping. Topics include basic concepts of GPS; projection systems; types of data; mission planning; and data capture, correction and export to geographical information systems (GIS). *Preq:* Senior standing or consent of instructor.

FOR (E N R) 634 Geographic Information Systems for Landscape Planning 3(2,3) Develops competence in geographic information systems (GIS) technology and its application to various spatial analysis problems in landscape planning. Topics include data development and management, spatial analysis techniques, critical review of GIS applications, needs analysis and institutional context. GIS hardware and software, hands-on application. Credit may be received for only one of C R P 434, FOR (E N R) 434.

FOR 641 Properties of Wood Products 3(3,0) Basic properties of wood including the hygroscopic, thermal, electrical, mechanical and chemical properties; standard testing procedures for wood. *Preq:* Junior standing or consent of instructor.

FOR 642 Manufacture of Wood Products 3(3,0) Manufacture of lumber, plywood, poles, piles; drying, preservation, grading and uses of wood products. Manufacture of particleboard, flakeboard, oriented-strand board, fiberboard and paper products. Includes physical, mechanical and chemical properties and their applications. *Preq:* Consent of instructor.

FOR 644 Forest Products Marketing and International Trade 3(3,0) Study of 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. *Preq:* FOR 442 or consent of instructor.

FOR 650 Woody Plant Stress Physiology 3(3,0) Structure, function and physiology of tree shoot and crown growth, wood formation, diameter growth, root growth and reproduction, especially as related to stress factors. *Preq:* BIOSC 401 or FOR 460 or consent of instructor.

FOR (EE&S, B E) 651 Newman Seminar and Lecture Series in Natural Resources Engineering 1(0,2) See B E 651.

FOR 665 Silviculture 4(3,3) Discussion of the theory and practice of manipulating forests to meet the needs and values of landowners and society in accordances with biological, ecological and economic principles. *Preq:* FOR 206 and Forestry Summer Camp or consent of instructor.

FOR 707 Special Problems in Forestry 1-3(1-3,0) Directed individual study of a special problem in an applied field of forestry. Written report of study results is required.

FOR 805 Forest Landscape Ecosystems 4(3,3) Three basic landscape components of soils, landform and vegetation; their interrelationships in forest ecosystems; factors and processes of soils as interacting components with landform and vegetation. Offered fall semester of even-numbered years only. *Preq:* Graduate standing or consent of instructor.

FOR 806 Advanced Silviculture—Forest Tree Growth and Development 3(3,0) 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. Offered fall semester of odd-numbered years only. *Preq:* BIOSC 401, 402; or consent of instructor.

FOR 807 Special Problems in Forestry 1-12 Special problems in forestry research methods that do not directly pertain to the candidate's thesis.

FOR 811 Forest Wetland Ecology and Management 2(2,0) Assessment of ecological processes and how they influence forest wetland productivity, management and regulation. Offered spring semester only. *Preq:* Introductory ecology or consent of instructor.

FOR 812 Fire Ecology and Management 3(2,3) 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. *Preq:* Graduate standing or consent of instructor.

FOR 814 Advanced Forest Resource Management and Planning 3(3,0) 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. Offered spring semester of odd-numbered years only. *Preq:* FOR 417 or consent of instructor.

FOR 815 Systems Processes in Natural Resources 3(2,3) Use of system thinking and system analysis to define the issues, model, simulate and evaluate alternatives for forest landscape problems and opportunities.

FOR (PRTM) 816 Remote Sensing and GIS in Natural Resources 3(2,3) Practical application of computer mapping, spatial analysis and natural resource inventory using remote sensing and geographical information systems. Offered spring semester of odd-numbered years only. *Preq:* FOR (E N R) 434 or consent of instructor.

FOR 845 Biodiversity in Managed Forests 3(2,3) Theory and practice of maintaining biodiversity are fundamental to successful management of forests. Conservation of biodiversity is viewed from the macro (landscape) and micro (stand) levels. Socioeconomic and policy as well as ecological perspectives are considered in design of appropriate management practices. *Preq:* FOR 415, 460, or consent of instructor.

FOR 891 Master's Thesis Research 1-12

FOR 893 Selected Topics in Forest Resources 1-4(0-4,0-12) Specialized topics not covered in other courses which explore current areas of research and management in forest and natural resources in a format of lecture, lab, or both. May be repeated for a maximum of eight credits, but only if different topics are covered. *Preq:* Graduate standing or consent of instructor.

FOR 991 Doctoral Dissertation Research 1-12

FORESTRY AND NATURAL RESOURCES

F N R 666 Stream Ecology 3(2,3) Covers the ecology of flowing water systems. Topics include geomorphology, physical and chemical factors of streams, biology of stream-dwelling organisms, trophic relationships, competition, colonization, drift, community structure, disturbance and human impacts. *Preq:* Junior standing or consent of department chair.

F N R 730 Master Naturalist for Teachers 3(2,4) Teachers learn about the natural history and natural resources of South Carolina, including geology, biology, ecology and human impacts. Additionally, this online course with associated field trips may be used to help teachers as part of obtaining certification through the South Carolina Master Naturalist program.

F N R 808 Graduate Seminar 1(1,0) Covers research methods, current literature, scientific communication and scientific presentations in forestry, forest resources and wildlife and fisheries science. To be taken Pass/Fail only. May be repeated for a maximum of two credits.

FRENCH

FR 151 French for Graduate Students 3(3,0) 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. To be taken Pass/Fail only. May be repeated once for credit. *Preq:* Graduate standing.

FR 699 Selected Topics in French Literature 3(3,0) Selected topics that have characterized French literature, language and culture. May be repeated for a maximum of six credits. *Preq:* Consent of department chair.

GENETICS

GEN(BIOSC) 605 Molecular Genetics of Eukaryotes 3(3,0) 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. *Preq:* GEN 302 or equivalent and one semester of biochemistry, or consent of instructor.

GEN 610 Population and Quantitative Genetics 3(3,0) Classical and computational genetics topics, including Mendelian vs. non-Mendelian inheritance, genetic variation, evolutionary, conservation, coalescent theory, molecular evolution, quantitative trait locus, and association mapping in the framework of population and quantitative genetics. *Preq:* EX ST 301 and GEN 302 with a C or better, or consent of instructor.

GEN 611 Population and Quantitative Genetics Laboratory 2(0,4) Crosses are performed using eukaryotic organisms with appropriate markers, and molecular markers are amplified, sequenced and analyzed. Collected data are used to test hypotheses regarding possible modes of inheritance and for patterns of molecular evolution. Population and molecular evolutionary genetics concepts are also examined. *Preq:* GEN 410 or concurrent enrollment, or consent of instructor.

GEN 620 Molecular Genetics and Gene Regulation 3(3,0) Molecular genetics, including replication, transcription and translation, gene expression, recombinant DNA technology, developmental, human, cancer and behavioral genetics. *Preq:* BIOCH 301 and GEN 302 with C or better, or consent of instructor.

GEN (BIOCH) 640 Bioinformatics 3(3,0) Theory and application of computational technology to analysis of the genome, transcriptome and proteome. *Preq:* GEN 302 and BIOCH 301 with a C or better, or consent of instructor.

GEN 650 Comparative Genetics 3(3,0) Outlines the genome structure, function and evolution based on available complete genome sequences. Topics include evolution of multigene families, origin of eukaryotic organelles, molecular phylogeny, gene duplication, domain shuffling, transposition and horizontal gene transfer. *Preq:* GEN 420 and 440 with a C or better, or consent of instructor.

GEN 670 Human Genetics 3(3,0) Basic principles of inheritance; population, molecular and biochemical genetics; cytogenetics; immunogenetics; complex traits; cancer genetics; treatment of genetic disorders; genetic screening and counseling; and the Human Genome Project. *Preq:* GEN 300 or 302 with a C or better, or consent of instructor.

GEN (ENT) 695 Insect Biotechnology 3(3,0) See ENT 695.

GEN 730 Genetics Topics for Teachers 3(2,2)

Lectures and laboratories focus on genetics and biotechnology. Restricted to elementary and secondary teachers. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* Consent of instructor.

GEN 801 Cytogenetics 3(2,3) Classical and contemporary problems of chromosome structure, behavior and transmission; recombination; interspecific hybridization; euchromatin and heterochromatin; polyploidy; mutable genetic systems; structural and numerical aberrations of chromosomes and their effects upon breeding systems of plants and animals. Offered spring semester of alternate years only. *Preq:* GEN 302 or equivalent.

GEN 803 Quantitative Genetics 3(3,0) Quantitative genetics concepts, line crosses and inbreeding, detecting major genes, mapping quantitative trait loci, estimation of genetic variation and heritability. Offered spring semester only. *Preq:* GEN 814 or consent of instructor. (EX ST 801 is recommended.)

GEN (BIOCH) 805 Issues in Research 3(3,0) See BIOCH 805.

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

GEN (BIOCH) 810 Principles of Molecular Biology 3(3,0) See BIOCH 810.

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

GEN 814 Advanced Genetics 3(3,0) Topics include organization of DNA in prokaryotes and eukaryotes, mutation, extranuclear inheritance, recombination, control of gene activity, systems of mating, genes and development, genetics of behavior, population genetics, genetics and disease. *Preq:* GEN 302 or equivalent, graduate enrollment in Genetics, or consent of instructor.

GEN 815 Developmental Genetics 3(3,0) Current research in developmental genetics including model systems, homeotic genes of *Drosophila*, primary induction, adhesion, molecules and cancer, axis formation, global pattern mutants in plants, homeobox genes in plants, and photo regulation. *Preq:* GEN 814 or consent of instructor.

GEN (BIOCH) 820 Genomics and Proteomics 3(3,0) Genomes, transcriptomes and proteomes of a variety of organisms are studied along with the technology used to obtain them. Bioinformatics tools and access to this information are developed, and the significance of this information for the life sciences is made clear. *Preq:* BIOCH 814 or GEN 814 or consent of the instructor.

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

GEN 830 Molecular Evolution and Population

Genetics 3(3,0) Topics include statistical methodology in the study of population genetics, probability as applied to genetic systems, gene and zygotic frequencies, derivation of genetics expectation, forces that change gene frequency, inbreeding, estimation, and testing of genetic parameters. *Preq:* GEN 814 or consent of instructor. (EX ST 801 is recommended.)

GEN (BIOCH) 851 Seminar II 1(1,0) See BIOCH 851.

GEN 890 Special Topics in Genetics 1-3(1-3,0)

Group discussion of recent developments in genetic research. May be repeated for a maximum of six credit hours. *Preq:* GEN 302 and consent of instructor.

GEN 891 Master's Thesis Research 1-12

GEN 991 Doctoral Dissertation Research 1-12

GEOGRAPHY

GEOG 601 Studies in Geography 3(3,0) Intensive study of the geography of a selected world regions, such as North America, Europe, or the Middle East or the geography of a topic, such as the geography of oil or the geography of underdevelopment. May be repeated once for credit with departmental consent. *Preq:* GEOG 101 or 103 or consent of instructor.

GEOG 610 Geography of the American South 3(3,0) Study of geography of the American South in its changing complexities of almost 400 years of development. *Preq:* GEOG 101 or 103 or consent of instructor.

GEOG 620 Historical Geography of the United States 3(3,0) Survey that places the spatial concepts of geography into a time sequence with emphasis on the United States. *Preq:* GEOG 101 or 103 or consent of instructor.

GEOG (PRTM) 630 World Geography of Parks and Equivalent Reserves 3(3,0) See PRTM 630.

GEOG 640 Geography of Historic Preservation

3(3,0) Aspects of historic preservation with emphasis on sites and structures in their geographical, historical and socioeconomical contexts. Examples are drawn from American architectural styles and settlement forms. *Preq:* GEOG 101 or 103 or consent of instructor.

GEOG 710 Teaching Geography 3(3,0) 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.

GEOLOGY

GEOL 603 Invertebrate Paleontology 3(2,3) Study of life of past geologic ages, as shown by fossilized remains of ancient animals, with emphasis on the invertebrates. *Preq:* GEOL 101 or consent of instructor.

GEOL 605 Surficial Geology 4(3,3) Study of surface features of the earth and the processes that produce them. Analysis of landforms including their form, nature, origin, development, and rates and patterns of change. Laboratory studies emphasize terrain analysis and the mechanics of surficial geological processes. *Preq:* GEOL 102, 300, or consent of instructor.

GEOL 608 Geohydrology 3(3,0) Study of the hydrologic cycle, aquifer characteristics, theory of groundwater movement, mechanics of well flow, experimental methods and subsurface mapping. *Preq:* GEOL 101, 102.

GEOL 609 Environmental and Exploration Geophysics 4(3,3) Students develop an understanding of the principles and methods used to acquire, analyze, and interpret geophysical data. Emphasis is on seismic/radar, gravimetric, and electromagnetic methods. Applications to hydrogeology, environmental engineering and science, soil science, contaminant transport and remediation, near surface geology, geotechnical problems, oil and gas exploration, and carbon sequestration. *Preq:* GEOL 313 or consent of instructor.

GEOL 613 Stratigraphy 3(2,2) 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. Emphasis is placed not only on traditional litho-stratigraphy but also on modern seismic stratigraphy, biostratigraphy, magnetostratigraphy and current stratigraphic issues. *Preq:* GEOL 314 or consent of instructor.

GEOL 615 Analysis of Geological Processes 3(3,0) Introduction to methods for analyzing geological processes. Mathematical methods are introduced to solve problems related to stream flow, reaction kinetics, radioactive decay, heat flow, diffusion, fluid flow through geologic media and related processes. Coreq: MTHSC 206 or consent of instructor.

GEOL 621 GIS Applications in Geology 3(1,4) Introduction to geographic information systems with applications to current geological and hydrological problems. Topics include use of global positioning systems, spatial analysis and image analysis. Hands-on training with GIS software and techniques is covered. *Preq:* Senior standing, strong computer skills.

GEOL 651 Selected Topics in Hydrogeology

1-4(1-3,0-3) 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. *Preq:* GEOL 300 or 408 or consent of instructor.

GEOL 659 Biogeochemistry 3(3,0) Examines how biology directs mass and energy transfer between the lithosphere, biosphere, hydrosphere and atmosphere. The scale of examination ranges from molecular to global. Topics include element cycling, mineral-microbe/plant interface, biomineralization, and biogeochemical applications to bioremediation, ecology, environmental toxicology and biotechnology. *Preq:* CH 102 or GEOL 318 or consent of instructor.

GEOL (CSENV, ENTOX) 685 Environmental Soil Chemistry 3(3,0) See CSENV 685.

GEOL 790 Selected Topics in Earth Sciences 1-6(0-6,0-18) 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 803 Geostatistics 3(3,0) 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. *Preq:* EX ST 301 or MTHSC 301.

GEOL (EE&S) 806 Aquifer Characterization 3(3,0) 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 (EE&S) 808 Groundwater Modeling 3(3,0) 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. *Preq:* Consent of instructor.

GEOL (EE&S) 809 Subsurface Remediation Modeling 3(3,0) Lectures and computer exercises involving subsurface remediation methods including groundwater extraction, soil vapor extraction, stream flooding and a variety of other techniques; modeling flow of multiphase and multicomponent mixtures in porous medium. *Preq:* GEOL (EE&S) 808 or consent of instructor.

GEOL (EE&S) 810 Analytical Methods for Hydrogeology 3(3,0) Analytical mathematical methods for modeling subsurface fluid flow and transport processes including saturated water flow, unsaturated zone gas flow, chemical transport and heat transfer, emphasizing the derivation and solution of governing equations for modeling subsurface flow and transport. *Preq:* GEOL (EE&S) 808 or graduate-level groundwater course or consent of instructor.

GEOL 813 Environmental Geochemistry 3(3,0) 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 nonferrous metal mining, coal mining and coal use, and gasoline additives; urban and regional geochemistry. *Preq:* GEOL 318 or consent of instructor.

GEOL 814 Environmental Sedimentology 3(3,0) Environmental-based applications of sedimentology to developing an understanding of heterogeneity and scale, fluid flow and saturation, sediment-fluid interactions, and modeling approaches; field and laboratory methods; case studies; implications to environmental sustainability. *Preq:* Consent of instructor.

GEOL 816 Aquifer Systems 3(3,0) Hydrogeologic characteristics of selected major aquifer systems in the U.S. and elsewhere; conceptual models for the controls of recharge, discharge and flow-through aquifers in different geologic settings; development of numeric models to simulate natural and stressed aquifers. *Preq:* GEOL 408 and (EE&S) 808 or consent of instructor.

GEOL 818 Hydrogeology of Fractured Aquifers 3(3,0) Processes and characteristics of fluid flow through naturally and artificially fractured subsurface formations; principles of flow in dual porosity materials, characterizing fractures and fractured aquifers, mechanics of fracture formation, methods of inducing fractures from wells; case studies and applications. *Preq:* GEOL 408 and (EE&S) 808 or consent of instructor.

GEOL 850 Selected Topics in Environmental Geology 1-4(1-3,0-3) Selected topics in environmental geology emphasizing the subsurface contamination. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* Consent of instructor.

GEOL 851 Geology Seminar 1(1,0) Students review current topics in geology and make oral presentations. To be taken Pass/Fail only. May be taken twice for credit.

GEOL 875 Hydrogeology Summer Field Camp 6(4,6) Groundwater geology field techniques including examination of surface exposures, analysis of cores and geophysical well logs, subsurface mapping, aquifer performance test and groundwater remediation. *Preq:* Consent of instructor.

GEOL 891 Master's Thesis Research 1-12

GERMAN

GER 151 German for Graduate Students 3(3,0) Intensive program only for graduate students preparing for the reading examination in German. Minimum grade of B on final exam will satisfy Graduate School foreign language requirement. To be taken Pass/Fail only. May be repeated once for credit. *Preq:* Graduate standing.

GER 698 Independent Study 1-3(1-3,0) Selected topics in German literature, language, or culture. May be repeated for a maximum of six credits. *Preq:* Consent of department chair.

GRADUATE STUDIES

G S 799 Comprehensive Studies 1-15(1-15,0) Independent studies in preparation for comprehensive examinations; credit hours to be determined by the department or program chair. To be taken Pass/Fail only.

G S 800 Research Proposal Development Seminar 1(1,0) Principles and techniques for the preparation of research proposals. Does not count toward a graduate degree. To be taken Pass/Fail only. *Preq:* Second year or graduate standing in current major.

GRAPHIC COMMUNICATIONS

G C 606 Package and Specialty Printing 4(2,6) In depth study of the problems and processes for printing and converting in package label and specialty printing industries. Flexographic preparation, printing, die making, diecutting, transfer printing screen, container printing, pad printing and bar code production are covered. New developments and trends are discussed. Laboratory in techniques includes printing and converting. *Preq:* G C 310 or 340; or consent of instructor.

G C 607 Advanced Flexographic Methods 4(2,6) In-depth study of the 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. *Preq:* G C 606 or consent of instructor.

G C 640 Commercial Printing 4(2,6) Advances skills learned in previous graphic communications courses and applies the knowledge to large format presses. Students work from the design conception stage through all aspects of preparation, production and finishing. Emphasis is on understanding and incorporating emerging technologies into the production workflow. *Preq:* G C 310 and 350 or consent of instructor.

G C 644 Current Developments and Trends in Graphic Communications 4(2,6) Advanced course for Graphic Communications majors. Emphasis is on the theory and technical developments that affect process and equipment selection. Topics include color theory and application, electronic color scanning, electronic prepress and communications, gravure color quality control and analysis. *Preq:* G C 605, 606, 640.

G C 645 Advanced Screen Printing Methods 3(2,3) Systems and materials used in the screen printing process emphasizing techniques of control and procedures for establishing screen printing methods and standards. *Preq:* G C 207 or consent of instructor.

G C 646 Ink and Substrates 3(2,3) Covers components, manufacturing, process use and end use of ink and substrates used in lithography, flexography, gravure and screen printing. Examines the interrelationship among inks, substrates and the printing process. Through controlled testing and examination, the optimum conditions for improved printability are determined. *Preq:* G C 605; 606 or 640; or consent of instructor.

G C 648 Planning and Controlling Printing Functions 3(2,3) Study of systems for setting printing production standards, estimating, scheduling, job planning and the selection of new hardware and technologies. *Preq:* G C 350, 450, 605, 606, 640, or consent of instructor.

G C 690 Graphic Communications Selected Topics 1-3(1-3,0) Subjects not covered in other graphic communications courses; organized according to industry trends and student needs. May be repeated for a maximum of 18 credits, but only if different topics are covered. *Preq:* Consent of instructor.

G C 801 Process Control in Color Reproduction 3(2,3) 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. *Preq:* G C 644 or equivalent.

G C 811 Printing Industry Operations 3(2,3) 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 831 Color Science Applied to Graphic Communications 3(2,3) Color reproduction applications found in both photomechanical and digital workflows for print production; foundation in color science principles, measurement and integration relative to the printing, publishing and packaging industry; color systems development, application and integration. *Preq:* Consent of instructor.

G C 850 Graphic Communications Internship 1(1,0) Full-time employment for hands-on experiences in manufacturing, marketing, or managing within the graphic communications industry. For Graphic Communications graduate students only. May be repeated for a maximum of two credits. *Preq:* G C 310 or equivalent and consent of instructor.

G C 891 Master's Thesis Research 1-6(1-6,0) Student participation in a research project. Basic skills in a selected research methodology are developed. *Preq:* G C 894.

G C 894 Graphic Communications Graduate Seminar 1(1,0) Discussions on relevant topics and guidance to prepare research proposals in the graphic communications field. May be repeated for a maximum of two credits, but only if different topics are covered. *Preq:* Graduate standing and consent of instructor.

G C 897 Graphic Communications Research Problems I 3(3,0) In-depth investigation of phenomena relative to the printing, publishing, packaging, or allied industries. *Preq:* G C 894, acceptance of a written proposal, approval of advisor.

G C 898 Graphic Communications Research Problems II 3(3,0) Continuation of G C 897. In-depth investigation of phenomena relative to the printing, publishing, packaging, or allied industries. *Preq:* G C 894, 897, acceptance of a written proposal, approval of advisor.

HEALTH

HLTH 600 Selected Topics in Health 1-3(1-3,0) Topics in health selected to meet special and individualized interests of students. May be repeated for a maximum of nine credits, but only if different topics are covered. *Preq:* Junior standing, consent of instructor.

HLTH 610 Maternal and Child Health 3(3,0)

Focuses on key issues concerning the health status and needs of mothers and children. Topics include primary health care, measurement and indicators of health status, health of minorities, role of families and major programmatic interventions towards the health needs of these two groups.

HLTH 615 Public Health Issues in Obesity and Eating Disorders 3(3,0) In-depth review of prevalence, risk factors, consequences and treatments of obesity and other eating disorders. Focuses on the public health importance of cultural norms, prevention and early intervention as it relates to obesity and eating disorders. *Preq:* Junior standing in Health Science or consent of instructor.

HLTH 620 Health Science Internship 1-6(0,3-18)

Under supervision in an approved agency, students have an opportunity for on-the-job experiences. Students are placed in an agency and develop personal/professional goals and objectives appropriate to the setting, population and health issues. Students create a comprehensive exit portfolio in a digital format. *Preq:* HLTH 419, minimum grade-point ratio of 2.0, Junior standing in Health Science, consent of instructor.

HLTH 630 Health Promotion of the Aged 3(3,0)

Focuses on analysis and evaluation of health issues and health problems of the aged. Emphasis is on concepts of positive health behaviors. Health majors and minors will be given enrollment priority. *Preq:* Developmental psychology; a two-semester sequence in science; or consent of instructor.

HLTH 650 Applied Health Strategies 3(3,0)

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. *Preq:* HLTH 480, Health Science major.

HLTH 698 Improving Population Health 3(3,0)

Critical examination of current and emerging issues in improving public health practice and population health. Covers examples in empirical and applied research, revealing future trends in population health. Health majors and minors will be given enrollment priority. *Preq:* HLTH 240, 298, 380, or consent of instructor.

HLTH 802 Health Economics 3(3,0)

Provides in-depth exposure to economic concepts and theory as applied to the health services sector. Topics include health-care demand and supply analysis, consumer behavior, production and costs, perfect competition vs. healthcare competition, price discrimination and regulation. *Preq:* Undergraduate course in principles of economics.

HLTH (MICRO) 809 Epidemiological Research 3(3,0) See MICRO 809.

HLTH 810 Health Policy 3(3,0) Provides experience in analysis of decisions in health-care management policy, problems, resources and alternative courses of action for health service organizations. Students participate in analysis of organization objectives and means for achieving health service goals. *Preq:* HLTH 807 or M B A (FIN) 807, M B A 803, 806, 808, MGT (M B A) 809 or equivalent.

HEALTH ADMINISTRATION

M H A 717 Selected Topics in Health Administration 1-3(1-3,0) Variable topics are taught to reflect current state-of-the-art issues. May be repeated for a maximum of six credits, but only if different topics are covered.

M H A 719 Health Care Management 3(3,0) Focuses on the structure and function of the well managed and appropriately led acute care hospital. Other health service organizations are also considered and general management and operations theory are discussed.

M H A 721 Health Care Delivery Systems 3(3,0) Overview of the development of the health services delivery system in the United States.

M H A 722 Health Behavior and Epidemiology 2(2,0) Focuses on understanding the health behavior of a population and individuals. Introduces the concept of the health status of a population and discusses both methods of measurement and sources of data.

M H A 724 Health Care Ethics 3(3,0) Examination and analysis of the professional standards, laws and political and economic forces that establish a context for health care ethics.

M H A 732 Outcomes Assessment and Evaluation in Health Services 3(3,0) Introduces the 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.

M H A 735 Health Law and Risk Management 2(2,0) Introduces legal concepts and issues related to health care management.

M H A 741 Seminar in Community and Rural Health 3(3,0) Introduces community health planning concepts and explores methods and the unique aspects of rural health among the population residing there.

M H A 743 Managing with Health Professionals 3(3,0) Devoted to learning about clinical professionals and exploring ways to facilitate effective and efficient team relationships in the management and delivery of health services.

M H A 752 Health Administration Field Project 3(3,0) Provides an opportunity to apply principles, theories and concepts to a well-defined problem or issue currently confronting the health service administrator.

M H A 853 Seminar in Health Administration and Leadership 2(2,0) Integrates knowledge and skills acquired across all courses in the context of strategic management.

HEALTH, EDUCATION AND HUMAN DEVELOPMENT

HEHD 600 Introduction to Leadership Theories and Concepts 3(2,1)

Interdisciplinary course introduces students to the nature of leadership. Students gain a broad understanding of the history and origins of leadership, theoretical approaches to leadership and the essence of contemporary leadership. Students are encouraged to test their ability to apply these concepts to life experiences. *Preq:* Junior standing or consent of instructor.

HEHD 610 Leadership Behavior and Civic Engagement 3(2,1)

Students couple concepts of social justice and civic engagement with theoretical foundations from HEHD 400 to complete a comprehensive theory-to-practice project. Introduces students to a comprehensive leadership skill set to become active change agents for the common good. *Preq:* HEHD 400.

HEHD 620 Leadership Application and Experience 3(2,3)

Immerses students in a practical leadership experience utilizing knowledge and skills gained in HEHD 400 and 410. Students identify an issue or problem and practice leadership by developing and implementing a community project. Challenges students to commit themselves to long-term engagement as agents of change. *Preq:* HEHD 410.

HEHD 800 Theories of Youth Development: An Applied Perspective 3(3,0)

Examines theories of positive youth development with an emphasis on how to apply them to "real world" issues facing young people. Students explore existing models, read theoretical and applied literature and examine current social changes that impact positive youth development.

HEHD 801 Child and Adolescent Development 3(3,0)

Focuses on child and adolescent development emphasizing a strength-based approach. Students develop an understanding of early childhood and adolescent growth and development from a social, cultural and psychological perspective.

HEHD 802 Youth Development Programming in a Contemporary Society 3(3,0)

Focuses on programs and administrative policies and procedures that govern youth development programs at the local, state and national levels. Model programs emphasizing "best practices" are studied. A cross-sectional approach is used to examine assets and protective factors in the contexts of family, school and community.

HEHD 803 Creative and Ethical Leadership in a Changing Society 3(3,0)

Focuses on the development of leadership skills and group dynamics in program development and supervision of staff and volunteers. Students engage in listening, empowerment and process skills utilizing the latest approaches in the field of communications. Professional ethics related to human service professionals are integrated.

HEHD 804 Assessment and Evaluation of Youth Programs 3(3,0)

Focuses on developing knowledge of rationale, procedures and tools for conducting intake, needs and environmental assessments of youth, families and communities. Effective skills for mastering comprehensive program evaluation strategies are taught. Students explore statistical packages specifically appropriate for evaluation of youth programs.

HEHD 805 Youth Development in the Context of Family 3(3,0) Focuses on youth development in the context of family development and interpersonal relationships. Students gain knowledge and skills in development issues and family functioning. Students become aware of and respect diverse family structures, parental involvement and the influence of culture and ethnicity on family dynamics.

HEHD 806 Youth Development in the Context of a Global and Diverse Society 3(3,0) Focuses on specific circumstances and issues related to youth in at-risk environments. Students learn methods, strategies and techniques to address diversity issues (i.e. racial, ethnic, gender, disability, sexual preference). Issues of poverty, mass culture, physical environment, etc. are examined globally.

HEHD 807 Internship in Youth Development 3(0,9)

Practical experience in youth-serving agencies/organizations. Students are required to complete a minimum of 150 hours of experiential education in a supervised setting. Upon approval, exceptions are given to students with experience working in youth-related fields. To be taken Pass/Fail only. *Preq:* Consent of program coordinator.

HEHD 808 Grantsmanship 3(3,0)

Students conduct searches to identify youth-related funding sources. They write proposals to include purpose, rationale, background information, literature review, identification of collaborators/partners, budget, budget justification and human subjects review. *Preq:* Admission to MS in Youth Development Leadership Program.

HEHD 809 Management of Staff and Volunteers 3(3,0)

Examines approaches and strategies for successful management and development of staff and volunteers in youth-serving organizations, including effective organizational systems and working with boards and advisory committees. Covers business and organizational principles and practices for success as well as challenges of recruiting, supervising and retaining staff and volunteers. *Preq:* Youth Development Leadership major or consent of instructor.

HEHD 889 Independent Study in Youth Development 1-6(16,0)

Provides opportunities for students in youth development leadership to explore areas of special interest and critical topics in the discipline of youth development. May be repeated for a maximum of six credit hours. *Preq:* HEHD 800.

HEHD 891 Master's Project I 3(3,0) Students are assisted in the preparation and completion of a graduate-level evaluative research project. Students share research project ideas with classmates and work to complete specific assignments, such as hypothesis development, literature review and research methodology proposed to prepare for data collection, analysis and final project presentation. *Preq:* EX ST 801, HEHD 800, 804.

HEHD 892 Master's Project 3(0,9)

Students conduct evaluative research projects to include writing an article for submission to a professional journal. Students present articles to instructor for review. To be taken Pass/Fail only. *Preq:* Consent of program coordinator.

HEALTHCARE GENETICS

HCG 901 Advances in Human Genetics 3(3,0)

Overview of the disciplines and content areas related to advances in human genetics/genomics. Topics include aspects of biochemical, molecular, population genetics and cytogenetics as they relate to genomic health care. Bioinformatics is addressed, incorporating the use of genetic databases for research and clinical settings.

HCG 903 Interdisciplinary Research 1(1,0)

Examination of interdisciplinary research in the life sciences as a means of integrating information, data, techniques, tools, perspectives, concepts and/or theories from two or more disciplines or bodies of specialized knowledge to advance knowledge development or solve problems. *Preq:* Consent of instructor.

HCG 905 Genomics, Ethics and Health Policy 3(3,0)

Designed for health-care professionals. Analyzes relationships among political climate, policy design and government action as related to ethical, legal and social issues surrounding availability of genetic information. Examines an ethical perspective and outcomes on health policies relating to genomic issues as well as contemplated actions based on new medical techniques. *Preq:* Consent of instructor.

HCG 907 Applied Healthcare Genetics 3(3,0)

The principles of genetics are being utilized to individualize healthcare with new resources available to professionals for research and education. This course will focus on applying principles and issues in the areas of translation research, intervention and policy to establish a working knowledge of healthcare genetics. *Preq:* Doctoral standing or consent of instructor.

HCG 910 Research Seminar 1-9(1-9,0)

Discussion of current research developments in healthcare genetics. May be repeated for a maximum of nine credits, but only if different topics are covered. *Preq:* Doctoral standing.

HCG 989 Selected Topics 1-9(1-9,0)

Group discussions of trends and recent developments in research related to healthcare genetics. May be repeated for a maximum of nine credits, but only if different topics are covered. *Preq:* HCG 901 and consent of instructor.

HCG 991 Doctoral Dissertation Research 1-18

Focuses on specific research topic identified and agreed upon by the designated dissertation committee. *Preq:* Doctoral standing.

HISTORIC PRESERVATION

H P 610 History and Theory of Historic Preservation 3(3,0)

Survey history of preservation that explores a variety of theoretical issues that impact the discipline. Provides a basis for critical evaluation of historic preservation. *Preq:* Three semesters of Art and Architectural History or equivalent or consent of instructor.

H P 611 Archival Research and Oral History in Historic Preservation 3(3,0)

Introduction to historic buildings and landscapes research. Emphasizes researching the physical and social history of buildings and places. Charleston and its environs provide case study projects for archival research.

H P 612 Materials and Methods of Historic Construction 3(3,0) Survey of traditional materials and methods of construction in America from the 18th through the early 20th century. Scientific examination of historic construction provides case studies. *Preq:* Three semesters of Art and Architectural History or equivalent or consent of instructor.

H P 800 Historic Preservation Internship 1-3(1-6, 3-18) Six credits of approved internship in Historic Preservation are required during the course of the graduate program and can be completed in one summer of the program. May be repeated for a maximum of six credits. To be taken Pass/Fail only. *Preq:* Consent of supervising faculty.

H P 801 Legal and Economic Issues in Historic Preservation 3(3,0) Examines historic preservation against the backdrop of contemporary legal and economic issues. *Preq:* ARCH 405, H P 410, 411, 412; or consent of instructor.

H P 802 Historic Preservation Research Seminar 3(3,0) Advanced documentation and analysis of historic resources in preparation for thesis project. *Preq:* H P 801, 805.

H P 803 Advanced Materials and Methods in Conservation 3(3,0) Advanced study of historic building materials and conservation techniques. *Preq:* H P 805. Coreq: H P 810.

H P 804 Management and Administration of Historic Preservation 3(3,0) Praxis on the management of historic properties with emphasis on administering a preservation project in the field and establishing a maintenance program for a historic property. *Preq:* H P 810.

H P 805 Preservation Studio 6(0,18) Examines Charleston and its environs through the development of a comprehensive preservation project for a specific site. *Preq:* ARCH 405, H P 410, 411, 412. Coreq: H P 801.

H P 806 Society and Culture of Early Charleston 3(3,0) Examines the society and culture of early Charleston (c. 1670–1861) through a localized analysis of important topics in American social/cultural history. Topical study is applied to an investigation of extant Charleston buildings and urban fabric. *Preq:* H P 610 or consent of instructor.

H P 810 Conservation Lab in Historic Preservation 6(0,18) Conservation of historic materials on site and in the lab. *Preq:* H P 805. Coreq: H P 803.

H P 811 Readings in Historic Preservation 3(3,0) Critical overview of the history, development and current practice of historic preservation focusing on the United States. Topics include American and European perspectives; the development of preservation as a profession; current theory and practice; and the use, abuse and fetishization of history. *Preq:* Enrollment in MS or certificate program in Historic Preservation.

H P 819 Investigation, Documentation and Conservation 3(3,0) Through study and application of the Historic American Buildings Survey, the standard method for creating baseline documents, students gain experience in the best investigation and documentation techniques. The method is applied to various structures located in Charleston's historic district. Students also gain a base understanding of conservation practices and techniques.

H P 823 Historic Interiors 3(3,0) Students gain familiarity with American interiors and decorative arts from early European settlement through the late 19th century. They consider periodization and documentation of the structure, finishes, decorations and the material culture of those structures with emphasis on the interpretation of primary documents: inventories, pattern books, accounts, paintings and prints.

HP 833 Cultural and Historic Landscape Preservation 3(3,0) Overview of cultural historic landscape preservation principles and practices. Includes inventory and analysis of historic resources from a cultural landscape perspective. Qualities of integrity are studied in correspondence to location, design, setting, materials, workmanship, and feeling and association. *Preq:* Enrollment in MS in Historic Preservation program or consent of instructor.

H P 859 Professional Project in Historic Preservation 3(3,0) Professional project is a thesis alternative that provides students with a more flexible presentation of their research to reflect essential preservation knowledge and skills. Students work directly with their committees to complete projects requiring a flexible presentation such as documentation drawings and other methods germane to historic preservation. *Preq:* Consent of advisor.

H P 890 Directed Studies 1-6(1-6,0) Special topics and independent research in historic preservation with faculty guidance. May be repeated for a maximum of six credits. *Preq:* Consent of advisor.

H P 891 Thesis Research 1-6 Thesis proposals are defended in the third semester and completed as a multimedia project in the fourth semester of the program. Projects using the historic resources of Charleston and its environs, or other suitable historic sites, are encouraged. To be taken Pass/Fail only. *Preq:* H P 802, 810.

HISTORY

HIST 600 Studies in United States History 3(3,0) Topics and problems in the history of the United States from the Colonial era to the present.

HIST 615 Introduction to Digital History 3(3,0) Introduces students to the philosophy and practice of the emerging field of History and New Media with a particular focus on how public historians can use technology to enhance their archival/museum/center's visibility with the general public. *Preq:* Any 300-level history course.

HIST 617 History and Tourism 3(3,0) Introduces students to important scholarship in the heritage tourism field. Examines the origins and objectives of heritage tourism, and case studies of how professionals employ heritage tourism. *Preq:* Any 300-level history course.

HIST 618 Oral History and Local History 3(3,0) Introduces students to the most recent work in oral history and methodology with a focus on the history on the Upstate and Appalachia from the colonial era to the present. Students engage in their own local oral history project and produce a research paper based on their findings. *Preq:* Any 300-level history course.

HIST 620 History and Film 3(2,3) Analyzes the role of the cinema in the construction and dissemination of history.

HIST 624 Topics in History of Medicine and Health 3(3,0) Selected topics in the development of medicine and health care including public attitudes towards health and medicine.

HIST 636 The Vietnam Wars 3(3,0) Wars in Vietnam are seen in two phases. The First Indochina War, 1946–54, is covered briefly. Main body of the course covers the Second Indochina War, which began as a guerrilla conflict in 1959–60 and ended as a mostly conventional war in the Communist victory of 1975.

HIST 638 Problems in African Historiography and Methodology 3(3,0) Concentrates on major issues in the field of African history with an additional focus on methodological concerns.

HIST 640 Studies in Latin American History 3(3,0) Consideration of selected and varied topics in Latin American history through readings, class discussions and individual or group projects. Special attention is 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(3,0) Selected topics in ancient history ranging from pre-Biblical times to the fall of the Roman Empire. May be repeated once for credit with departmental consent.

HIST 651 Alexander the Great 3(3,0) Focuses on the career of Alexander the Great and deals with the history and archaeology of ancient Macedonia.

HIST 660 Studies in British History 3(3,0) Examination of selected themes, topics, or periods in British history from Anglo-Saxon times to the present.

HIST 670 Studies in Early European History 3(3,0) Studies of selected topics or themes in European history from the fall of the Roman Empire to the age of industrialization.

HIST 671 Studies in Modern European History 3(3,0) Study of selected topics or problems in European history from the end of the Old Regime to the present.

HIST 687 World War II and the World 3(3,0) World War II was a cataclysm of the twentieth century that touched every part of the globe and ushered in the atomic age. This course examines the war from its origins in the aftermath of World War I to the war crimes trials and the dawn of the Cold War.

HIST 691 Studies in the History of Science and Technology 3(3,0) 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(3,0) Selected topics and problems in international conflict and conflict resolution among nations. Concentration is usually on 20th century history.

HIST 693 Studies in Social History 3(3,0) Studies in the 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(3,0) Selected topics in comparative history, contrasting and comparing similar historic developments in different nations, geographic areas, or civilizations.

HIST 695 Studies in the History of Ideas 3(3,0) 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(3,0) Selected problems in the development of law and the system of criminal and civil justice.

HIST 710 United States Since 1865 3(3,0) 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 consent of graduate program director.

HIST 775 Europe Since the 18th Century 3(3,0) 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 consent of graduate program director.

HIST 800 Seminar in United States History 3(3,0) Training in historical research and writing. May be repeated for credit with consent of graduate program director.

HIST 810 Culture and Society 3(3,0) Training in historical research and writing with a focus on the social and cultural underpinnings of U.S. history. May be repeated for credit as topics change with consent of graduate program director.

HIST 820 American Historiography 3(3,0) Graduate seminar designed to familiarize students with the major overarching themes, scholarly interpretations and issues of American history that historians have presented over the last century.

HIST 830 Seminar in Asian History 3(3,0) Training in historical research and writing with focus on Asian history. May be repeated for credit with consent of graduate program director.

HIST 840 Seminar in Latin American History 3(3,0) Training in historical research and writing with focus on Latin American history. May be repeated for credit with consent of graduate program director.

HIST 860 Seminar in British History 3(3,0) Training in historical research and writing with focus on British history. May be repeated for credit with consent of graduate program director.

HIST 870 Seminar in European History 3(3,0) Training in historical research and writing with focus on European history. May be repeated for credit with consent of graduate program director.

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

HIST 880 Special Topics in History 3(3,0) Training in historical research and writing. May be repeated for credit with consent of graduate program director.

HIST 881 Historiography 3(3,0) 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(3,0) Critical study of a historical topic, selected according to needs of the student and with approval of graduate program director. May be repeated for credit with consent of graduate program director.

HIST 887 Archival Management: An Introduction 3(3,0) Introduction to basic concepts of archival theory and management.

HIST 890 Thesis Prospectus Workshop 1(1,0) Workshop to help students prepare for writing their master's thesis by producing a prospectus that includes historiographical argumentation and sources.

HIST 891 Master's Thesis Research 1-12

HIST 893 Practicum in Archival Management 3(0,9) Hands-on experience in the operations of an archival program, including acquisitions, arrangements, descriptions, conservation and reference service. *Prreq:* HIST 887 or consent of instructor.

HIST 894 Practicum in Historical Editing 3(3,0) 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.

HORTICULTURE

HORT 612 Advanced Turfgrass Management 3(2,3) Advanced principles and practices associated with turfgrass management for golf courses, sports fields, sod production and commercial lawn care. Topics include turfgrass physiology, plant growth and development, construction, turfgrass nutrition, irrigation, drainage, pesticide use and fate, and development of effective management systems. *Prreq:* CSENV 202, HORT 212, or consent of instructor.

HORT 620 Applied Turfgrass Physiology 3(3,0) Advanced course in turfgrass science and management. Provides the current status and development of turfgrass stress physiology and research. Main topics include temperature, drought, traffic, edaphic stresses, new developments in the turf industry, and environmental stewardship. *Prreq:* HORT 212, 213.

HORT (FOR) 627 Urban Tree Care 3(3,0) See FOR 627.

HORT (CSENV) 633 Landscape and Turf Weed Management 3(2,2) Weed management strategies that include cultural, biological and chemical methods are studied for landscape and turfgrass areas. Problem-solving skills and herbicide characteristics are emphasized. *Prreq:* HORT 212 or consent of instructor.

HORT 655 Just Fruit 3(3,0) Students explore the origins, biology, culture and production of major temperate zone fruits—apples, berries and cherries to pawpaws, peaches and pomegranates, the familiar to the forbidden. They discover principles, practices and technologies employed to grow, protect and harvest the fruits that feed us from commercial orchards, organic farms and backyards. *Prreq:* HORT 101 or consent of instructor.

HORT 656 Vegetable Crops 3(3,0) 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 Advanced Landscape Garden Design 4(3,3) Garden design for urban and other highly visible locations. Students design a specific specialty garden with environmental education potential. Finished plans include detailed planting, installation and maintenance, and communication. Emphasis is on establishing healthy plant communities, habitat linkages, and healthy water and soil. *Prreq:* HORT 308 and 309, or consent of instructor.

HORT 671 Advanced Internship 1-6(0,2-12) Pre-planned work experience under competent supervision in approved agency dealing with horticultural endeavors. Gives 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. *Prreq:* Junior standing and consent of instructor.

HORT 672 Garden Experiences in Youth Development 2(1,3) Exploration of the role of gardening and related outdoor experiences in enhancement of educational development, self-esteem and prosocial behavior in elementary school children. *Prreq:* Senior standing and consent of instructor.

HORT 810 Specialized Topics in Environmental Horticulture 1-4(14,0) Specialized topics not covered in other courses that explore current areas of research and management in environmental horticulture. May be repeated for a maximum of eight credits, but only if different topics are covered. *Prreq:* Graduate standing or consent of instructor.

HORT 812 Special Problems in Horticulture 1-4(14,0) Research not related to a thesis. May be repeated for a maximum of four credits. *Prreq:* Consent of instructor.

HORT 814 Environmental Plant Stress Physiology 3(2,2) Environmental stresses associated with water (drought, waterlogging), temperature, light and air pollution with quantitative treatment of stress effects on plants; mechanisms by which plants may avoid, tolerate, or modify stress effects on plant growth and function at the molecular, cellular and whole-plant levels. Offered fall semester only. *Prreq:* BIOSC 401 and 402 or consent of instructor.

HUMAN RESOURCE DEVELOPMENT

H R D 820 Human Performance Improvement 3(3,0) Theory and practice of both instructional and noninstructional interventions and techniques used to improve human performance in the workplace. Covers fundamentals of human performance improvement, general processes of human performance improvement, and human performance interventions of a noninstructional nature.

H R D 825 Organizational Performance Improvement 3(3,0) Provides concepts and skills employed by managers and change agents to promote and sustain productive organizations. Students learn how to perform behavior analysis and management, how to determine criteria for performance appraisals and how to establish leadership in the workplace. *Prreq:* H R D 820, 830.

H R D 830 Concepts of Human Resource Development 3(3,0) 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. *Preq:* Consent of instructor.

H R D (CTE) 845 Needs Assessment for Education and Industry 3(3,0) 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. *Preq:* H R D 830 or consent of instructor.

H R D 846 Applied Public Relations 3(3,0) 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. *Preq:* Employment or ready access to an employer and place of employment; CTE 468 or 668 is desirable.

H R D (CTE) 847 Instructional Systems Design 3(3,0) 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. *Preq:* H R D (CTE) 845 or consent of instructor.

H R D 849 Evaluation of Training and Development/HRD Programs 3(3,0) Theory and practice of evaluation processes related to training and development in human resource development 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. *Preq:* AG ED (CTE, ED) 889, H R D (CTE) 847, (CTE) 860 or consent of instructor.

H R D (CTE) 860 Instructional Materials Development 3(3,0) 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. *Preq:* H R D (CTE) 845.

H R D (CTE) 870 Consulting for Education and Industry 3(3,0) Theory and practice of external and internal consulting practices in human resource development 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. *Preq:* H R D 830 or consent of instructor.

H R D 880 Research Concepts and Skills 3(3,0) Introductory course in research to familiarize human performance improvement professionals with the nature of research and reporting processes and to help develop the necessary criteria to become critical, analytical consumers of published research. *Preq:* H R D 820, 830.

H R D 882 Knowledge Management for Improved Performance 3(3,0) Introduction to knowledge management to familiarize students with organizational competencies required to adapt and prosper in a chaotic, global environment. Focuses on contemporary theory, research and application of knowledge management as a strategy for improving personal and organizational performance. *Preq:* H R D 880.

H R D 890 Instrumentation for Human Performance Improvement 3(3,0) Introduction to commercially available instruments used to assess and evaluate human performance in the workplace. Students develop critical judgment skills to determine the adequacy and use of instruments in modern organizations. *Preq:* H R D 880.

H R D 897 Applied Research and Development 3(3,0) Study of a specific topic under the direction of a faculty member. Students identify a special problem related to the human resource development profession based on their personal interests, experiences, needs and goals. *Preq:* Submission of a written proposal, prior approval of advisor, satisfactory completion of 12 hours of graduate H R D courses, AG ED (CTE, ED) 889.

HUMAN-CENTERED COMPUTING

H C C 831 Fundamentals of Human-Centered Computing 3(3,0) Fundamental concepts in human-centered computing, including human subjects, interface design, usability evaluation methods, software programming, information technology tools, ethics, policy, and current problems of interest to human-centered computing.

H C C 881 Selected Topics 1-3(1-3,0) Advanced topics from current problems of interest in human-centered computing. Topics vary from semester to semester. May be repeated for a maximum of 18 credits, but only if different topics are covered. *Preq:* Consent of instructor.

H C C 888 Directed Projects in Human-Centered Computing 1-6(1-6,0) Directed individual project supervised by department faculty. May be repeated for a maximum of 18 credits, but only if different topics are covered. *Preq:* Consent of instructor.

H C C 950 Selected Topics in Human-Centered Computing 1-3(1-3,0) Study of advanced topics from current problems of interest in human-centered computing. May be repeated for a maximum of 18 credits, but only if different topics are covered. To be taken Pass/Fail only.

H C C 991 Doctoral Dissertation Research 1-12(1-12,0) Doctoral Dissertation Research. May be repeated for a maximum of 99 credits, but only if different topics are covered. To be taken Pass/Fail only.

HUMANITIES

HUM (ENGL) 656 Literature and Arts of the Holocaust 3(3,0) See ENGL 656.

HYDROGEOLOGY

See courses listed under Geology.

INDUSTRIAL ENGINEERING

I E 600 Honors Thesis 1-6(1-6,0) Individual or joint research project performed with a faculty mentor or committee of faculty. May be repeated for a maximum of six credits. *Preq/Coreq:* I E H268 and consent of mentor.

I E 618 Human Factors Accident Analysis and Expert Testimony 3(3,0) This highly interactive course is divided into two components. Students gain an understanding of how the principles of human factors engineering are used in accident investigation and forensic analysis, and then learn the skills necessary to defend their opinions as an expert witness. *Preq:* COMM 150 or 250; I E 210.

I E 630 Introduction to Healthcare Systems Engineering 3(3,0) Focuses on how industrial engineers can partner with healthcare professionals to improve the quality and efficiency of healthcare delivery. Students learn about the current healthcare system, how healthcare is different from traditional industrial engineering sectors and the experiences of individuals in healthcare from engineering and non-engineering disciplines. *Preq:* I E 210.

I E 640 Decision Support Systems in Industrial Engineering 3(2,3) Design of decision support systems for production and service systems based on operations research models. Use of spreadsheets, databases and integrated software development environments to implement decision support systems. *Preq:* I E 280; CP SC 161 or I E 220.

I E 652 Reliability Engineering 3(3,0) Probabilistic approach to assessing system reliability. Methods for analyzing serial, parallel and complex systems. Reliability life testing and its acceleration are covered. Essential elements of maintainability are identified and related to system availability. *Preq:* I E 360.

I E 656 Supply Chain Design and Control 3(3,0) Industrial engineering aspects of supply chains including design and control of material and information systems. *Preq:* I E 386.

I E 657 Transportation and Logistics Engineering 3(3,0) Introduces transportation and logistics systems analysis from both analytical and practical perspectives. Covers methods for identifying level-of-service metrics and measuring system performance. Discusses key aspects of modeling, simulation and other techniques for economic and quantitative analysis of transportation and logistics planning issues. *Preq:* Senior standing in engineering, science, or management program; MTHSC 102 or 106.

I E 660 Quality Improvement Methods 3(3,0) Study of modern quality improvement techniques presented in an integrated, comprehensive context. *Preq:* Junior standing.

I E 661 Quality Engineering 3(3,0) Design aspects of quality and the engineer's role in problems of quality in production systems. *Preq:* I E 361.

- I E 662 Six Sigma Quality 3(3,0)** Study of DMAIC (Define, Measure, Analyze, Improve and Control) elements of Six Sigma, project management, process analysis, quality function deployment, hypothesis testing, gage R&R, data analysis, multivari-analysis, design of experiments, statistical process control and process capability analysis. *Preq:* EX ST 301, 411, I E 360, MTHSC 301, 302, or 309.
- I E 663 Quality in the Capital Projects Industry 3(3,0)** Covers topics in quality and lean principles relevant to the capital projects industry. Provides a broad overview on quality concepts and philosophies, quality management and inspection tools applicable to capital projects, Six Sigma Approach, lean concepts and value stream mapping. *Preq:* MTHSC 206.
- I E 665 Facilities Planning and Design 3(3,0)** Study of the principles and techniques of facility planning and design. Discusses economic selection of materials handling equipment and integration of this equipment into the layout plan to provide effective product flow in production, distribution and service contexts. Includes quantitative techniques for evaluation of facilities design. *Preq:* I E 280.
- I E 677 Systems Safety 3(2,3)** Introduces the issue of safety and response to significant events. Provides exposure to and experience in hazard and accident causes and mitigation. Emphasizes current theories applied to large, complex systems. *Preq:* Senior standing.
- I E 682 Systems Modeling 4(3,2)** The purpose, theory and techniques of modeling systems with dynamic events. Students learn a powerful analytical process to use in the analysis and improvement of systems in several industries, including transportation, logistics, manufacturing and service systems. Incorporates professional simulation software as a tool in evaluating the system performance. *Preq:* I E 361 and 381; or MTHSC 302, 440 and 441.
- I E 685 Industrial Systems Engineering 3(3,0)** Modeling and analysis of multistage decision processes, recursive optimization, process and system design, and control problems. *Preq:* I E 280, 381.
- I E 687 Industrial Safety 3(3,0)** Recognition and prevention of hazards; recognition and control of hazardous materials; developing and managing a safety program; designing inherently safe equipment and workplaces. *Preq:* Junior standing.
- I E 688 Human Factors Engineering 3(3,0)** Introduction to human performance and limitations in the design of effective and efficient systems. Covers issues related to changes in technology, impact of design on society, ethical issues in design of systems and the cost benefits from designing systems and environments that often challenge perceived notions of benefits. *Preq:* Junior standing; MTHSC 102 or 106.
- I E 689 Industrial Ergonomics and Automation 3(2,3)** Physical ergonomics and ergonomics in industrial settings including work physiology, the physical environment, automated systems and hybrid work systems. *Preq:* I E 210 or Senior standing.
- I E 691 Selected Topics in Industrial Engineering 1-3(0-3,0-9)** Comprehensive study of any timely or special topic in industrial engineering not included in other courses. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.
- I E 800 Human Factors Engineering 3(3,0)** Fundamentals of design for human use; human performance; applications of abilities and limitations to the design of tools, machines, facilities, tasks and environments for efficient, safe and comfortable human use. *Preq:* Consent of instructor.
- I E 801 Design and Analysis of Human-Machine Systems 3(3,0)** Methodologies used in the design and evaluation of human-machine systems including function and task analysis; questionnaires and interviews; scenarios, mock-ups 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. *Preq:* Graduate standing and consent of instructor.
- I E 802 Design of Human-Computer Systems 3(3,0)** 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. *Preq:* I E 801 or consent of instructor.
- I E 803 Engineering Optimization and Applications 3(3,0)** 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 post-optimality analysis, Markov chains. *Preq:* Graduate standing and consent of instructor.
- I E 804 Manufacturing Systems Planning and Design 3(3,0)** 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. *Preq:* Graduate standing and consent of instructor.
- I E 805 Foundations in Quality Engineering 3(3,0)** Fundamental tools of quality engineering and their application to real situations; advanced statistical process control, design of experiments, Taguchi techniques and Shainin methodologies. *Preq:* Graduate standing and consent of instructor.
- I E 809 Model Systems Under Risk 3(3,0)** Application of probabilistic methods to engineering problem solving and decision making. Cases are presented illustrating use of Markov chains, queuing processes and other stochastic models in practice. *Preq:* MTHSC 302 or consent of instructor.
- I E 811 Human Factors in Quality Control 3(3,0)** 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. *Preq:* Graduate standing and consent of instructor.
- I E 812 Work Science and Design 3(3,0)** Design methods for work and work systems; scientific and engineering basis of work and its analysis. *Preq:* Consent of instructor.
- I E 813 Occupational Ergonomics 3(3,0)** Theory and applications of ergonomics at work; human performance, fatigue, stress, work patterns, work environment.
- I E 815 Research Methods in Ergonomics 3(3,0)** Contexts and processes for research in ergonomics with emphasis on engineering problems; scientific and engineering methods; measurement; visual and physical tasks; simulation, laboratory and archival studies. *Preq:* MTHSC 884 or equivalent or consent of instructor.
- I E 850 Introduction to Capital Projects Supply Chain 3(3,0)** Introduces the phases of capital projects; design and control of the capital projects supply chain; challenges associated with each of the primary supply chain entities—owners, contractors and suppliers.
- I E 851 Data Collection, Analysis and Interpretation 3(3,0)** Collection and presentation of data for decision making in industry focusing on design and control of industrial processes. Includes application of inferential statistics to data from industrial engineering situations. *Preq:* I E 850 or consent of instructor.
- I E 852 Modeling and Decision Making 3(3,0)** Students formulate and resolve models of industrial engineering systems focusing on decision making. *Preq:* I E 851 or consent of instructor.
- I E 853 Foundations of Quality 3(3,0)** Discusses quality control and quality assurance techniques including control charting and supplier surveillance. Special attention is devoted to nontraditional applications such as those used in nonmanufacturing supply chain. *Preq:* I E 851 or consent of instructor.
- I E 854 Fundamentals of Supply Chain and Logistics 3(3,0)** Students apply model building and analytical techniques to design, optimize and control the supply chain and other logistics systems. *Preq:* I E 851 or consent of instructor.
- I E 855 Capital Projects Supply Chain 3(3,0)** Application of quantitative and qualitative tools and techniques to the design, control, management and optimization of the capital projects supply chain. *Preq:* MGT 856 or consent of instructor.
- I E 857 Industrial Safety and Risk Management 3(3,0)** Discusses safety and risk management issues in industrial engineering systems including hazard information systems, process safety, export control and federal and international safety regulation requirements. *Preq:* I E 850 or consent of instructor.
- I E 858 Case Studies in Capital Projects Supply Chain 3(3,0)** Analysis of case studies in the capital projects supply chain. *Preq:* I E 852, 853, 854, 855, 857, or consent of instructor.
- I E 859 Capstone Design Project 3(3,0)** Capstone experience in the design, control, management and optimization of capital projects supply chains. *Preq:* I E 858 or consent of instructor.
- I E 860 Dynamic Programming 3(3,0)** 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. *Preq:* I E 803.
- I E 865 Facility Planning and Design 3(3,0)** Planning and design of industrial facilities emphasizing automated production facilities; quantitative approaches to equipment design and evaluation of performance. *Preq:* I E 803.

IE 871 Industrial Testing and Quality 3(3,0) Design and use of component and product tests; automated inspection; test and inspection in integrated systems; cost-based models. *Prreq:* IE 661.

IE 880 Advanced Methods of Operations Research 3(3,0) Methods and applications of advanced operations research techniques; discrete optimization, integer and mixed integer programming, Boolean minimization, network optimization, permutation methods on implicit enumeration. *Prreq:* IE 803 or consent of instructor.

IE 881 Metaheuristics 3(3,0) Survey of selected metaheuristic techniques. Topics may include genetic algorithms and other evolutionary algorithms, tabu search and simulated annealing. Students implement multiple metaheuristics from problems throughout the semester in a high-level language.

IE 884 Advanced Engineering Economic Analysis 3(3,0) 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.). *Prreq:* Consent of instructor.

IE 886 Operations Research in Production Control 3(3,0) Latest techniques in scientific inventory management, scheduling and forecasting; operations research; statistics; computer methods; case studies. *Prreq:* IE 803.

IE 887 Advanced Methods in Simulation Modeling 3(3,0) Covers design and development of discrete event, system dynamics and agent-based models to explain behavior or improve performance. Addresses environments that include process flow, as well as social and behavioral systems. Advanced topics of study include input and output analysis. Modeling concepts are motivated with real-world examples from representative fields. *Prreq:* Consent of instructor.

IE 888 Advanced Probabilistic Methods, 3(3,0) Advanced treatment of stochastic optimization, potentially including single and multiple channel queues, Markov programming and stochastic optimal control. *Prreq:* Consent of instructor.

IE 890 Special Problems in Industrial Engineering 1-3(1-3,0) Principles and methods of industrial engineering applied to analysis of a current interest problem. May be repeated for a maximum of six credits. To be taken Pass/Fail only. *Prreq:* Consent of instructor.

IE 891 Master's Thesis Research 1-12

IE 892 Master's Design Project 3(1,6) Design project in industrial systems; integration of industrial engineering principles and methodologies; resolution of contemporary systems design problems. Project requires research, development, implementation planning, reporting and project assessment. *Prreq:* Consent of instructor.

IE 893 Selected Topics in Industrial Engineering 1-3(1-3,0) Selected topics in industrial engineering emphasizing new developments in systems science, systems analysis and operations research. May be repeated for credit. *Prreq:* Consent of instructor.

IE 895 Industrial Engineering Research Techniques 1(1,0) Series of weekly one-hour lectures given by students, faculty and guests on methods and issues involved in industrial engineering research. To be taken Pass/Fail only.

IE 971 Advanced Quality Engineering Seminar 3(3,0) Current topics in the research and development of quality engineering methodologies. *Prreq:* IE 871 or consent of instructor.

IE 991 Doctoral Dissertation Research 1-12

INTEGRATED PEST MANAGEMENT

I PM 601 Principles of Integrated Pest Management 3(3,0) Origins, theory and practice of integrated pest management. Relationships among crop production and protection practices are explored. Economics of various control strategies are considered. Integrated pest management field projects are studied. Conventional and integrated pest management approaches are compared. Multidisciplinary plant problem analysis is introduced. *Prreq:* CSENV 407, ENT 301, PL PA 310, or consent of instructor.

I PM 800 Special Problems in Plant Health 1-3(0,3-9) Directed individual study of a special problem in plant health. Emphasis is on organizing, conducting and reporting on independent investigation. *Prreq:* Consent of instructor.

LANDSCAPE ARCHITECTURE

LARCH 605 Urban Genesis and Form 3(3,0) Exploration of urban forms and developments within their historic context through off-campus, on-site lectures and exposure to historic cities and sites. Students visit historic and contemporary cities and analyze those places through readings and direct observations. Offered in the summer only. *Prreq:* LARCH 252 or consent of instructor.

LARCH 623 Environmental Issues in Landscape Architecture 3(3,0) Overview of environmental and ecological issues and their relationship to landscape architecture practice and design. *Prreq:* LARCH 452 or consent of instructor.

LARCH 633 Historic Preservation in Landscape Architecture 3(3,0) Study of historic landscape preservation in a number of contexts including gardens, vernacular landscapes, parks, cemeteries and battlefields. *Prreq:* LARCH 452 or consent of instructor.

LARCH 643 Community Issues in Landscape Architecture 3(3,0) In-depth study of issues relevant to community design. Overview of physical design and related social issues. *Prreq:* LARCH 452 or consent of instructor.

LARCH 653 Key Issues in Landscape Architecture 3(3,0) Overview of research in landscape architecture and study of relevant research methods. Students write proposals for their own projects positioned within the larger context of research in the profession. *Prreq:* Fifth-year Landscape Architecture student or graduate student, or consent of instructor.

LARCH 801 Landscape Architecture Orientation I 6(3,9) Focused study of design, design theory and design communication. Assigned readings, lectures and discussions link those topics to graduate-level explorations of design intervention in the cultural and natural landscape. *Prreq:* Students in First Professional MLA program or consent of instructor.

LARCH 802 Landscape Architecture Orientation II 6(3,9) Second-semester course of focused study in design, design theory and design communication. Assigned readings, lectures and discussions link those explorations to graduate-level study in nature, culture and design. Explorations begun in LARCH 801 are taken to greater depth and complexity. *Prreq:* Students in First Professional MLA program or consent of instructor.

LARCH 813 Advanced Regional Design 6(3,9) Advanced study and analysis of natural and cultural landscapes at the regional scale with an emphasis on South Carolina. Includes an exploration of landscape ecology as an informant to design and application geographic information systems. Each student also engages in independent research. *Prreq:* Students in Second Professional MLA or MArch program or consent of instructor.

LARCH 821 Research Methods 3(3,0) Foundations and procedures of landscape architectural research design and methods. Explores alternate research methodologies and the theory of knowledge regarding foundations, scope and validity. *Prreq:* LARCH 653.

LARCH 823 Advanced Community Design Studio 6(3,9) Studio focused on the study of communities. Students engage in a series of design explorations culminating in a mixed-use parcel on a large tract. Includes intensive study of growth and change in the contemporary landscape. New development in southeastern U.S. serves as a laboratory. *Prreq:* LARCH 653 or consent of instructor.

LARCH 830 Graduate Seminar I 3(3,0) Seminar including reading, writing and discussion on environmental and social/cultural issues in landscape architecture. Course is grounded in an exploration of the history of landscape architectural theory. *Prreq:* LARCH 802 or consent of instructor.

LARCH 840 Graduate Seminar II 3(3,0) Graduate seminar in one of the areas of departmental focus: growth and change, health and design, or restoration. *Prreq:* LARCH 830 or consent of instructor.

LARCH 843 Interdisciplinary Design and Research 6(3,9) Students participate in an interdisciplinary project linked to one of the focus areas in the department: health and design, restoration (environmental or cultural/historical), growth and change. Each student identifies a personal research project related to the larger team project. *Prreq:* LARCH 653 or consent of instructor.

LARCH 850 Graduate Colloquium 3(3,0) Series of lectures and presentations by graduating students, faculty members and guest designers and scholars. Students offer reviews and critiques of the various presentations. *Prreq:* LARCH 840 or consent of instructor.

LARCH 852 Advanced Urban Design 6(1,10) Advanced landscape architectural design in the urban context. Students study urban issues and offer design and sustainable management solutions for urban areas. Includes readings and theory component, as well as an opportunity to collaborate with architecture students. *Prq:* Second professional degree graduate status in Landscape Architecture with first professional undergraduate degree in Landscape Architecture.

LARCH 853 Advanced Interdisciplinary Design and Research 6(3,9) Continuation of LARCH 843 with an advanced interdisciplinary project linked to one of the focus areas in the department: health and design, restoration (environmental or cultural/historical), and growth and change. Each student identifies a personal research project related to the larger team project *Prq:* LARCH 843 or consent of instructor.

LARCH 890 Directed Studies 1-6(1-6,0) Special topics and independent research in landscape architecture with faculty guidance. May be repeated for a maximum of six credits. *Prq:* Consent of advisor.

LARCH 891 Thesis Project 6(1,15) Complex and sophisticated independent project in landscape architectural research and/or advanced design. *Prq:* LARCH 843 or consent of instructor.

LANGUAGE

LANG 600 Phonetics 3(3,0) Study of basic phonetic concepts used in the study of sounds and language.

LANG (PO SC) 685 Global Affairs and Government 3(3,0) See PO SC 685.

LAW

LAW 605 Construction Law 3(3,0) Provides a practical knowledge of 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. *Prq:* LAW 322 or consent of instructor.

LAW 620 International Business Law 3(3,0) Intensive examination of the historical background of modern public and private international law; selected issues of public international law—human rights, law of war, United Nation's system and international litigation; selected issues of private international law—international sales, international trade, and formation and operation of multinational businesses. *Prq:* LAW 322 or consent of instructor.

LAW 848 Law for Real Estate Professionals 3(3,0) Provides the real estate professional with the fundamentals of law as it applies in the real estate arena. Explores the various legal forms of ownership, the form and process of real estate transactions, and governmental regulation of land use. *Prq:* Graduate standing or consent of instructor.

LAW 850 Law for Professional Accountants 3(3,0) 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 are utilized. *Prq:* LAW 322 or equivalent.

LITERACY

EDLT 860 Reading Instruction in the Elementary School 3(3,0) Knowledge and skills necessary for teaching reading to varied types of elementary school learners. *Prq:* Consent of instructor.

EDLT 861 Fundamentals of Basic Reading 3(3,0) Historical progression of the teaching of reading; current theories and reading practices; teaching basic reading skills.

EDLT 862 Clinical Research in Reading 3(3,0) Reading research and literature; original investigation in such problems as development of reading skills and attitudes, clinical procedures and techniques is required. *Prq:* EDLT 861.

EDLT 863 Organizing and Supervising Reading Programs 3(3,0) Supervisory problems with planning reading programs; analysis of methods and materials of teaching; evaluation of reading programs. *Prq:* One of the following: EDLT 860, 861, 864, 865, 869.

EDLT 864 Teaching Secondary School Reading 3(3,0) Methods and materials for secondary reading programs in developmental, corrective, remedial, adapted, content and recreational areas.

EDLT 865 Evaluation and Remediation of Reading Problems 3(2,3) Remedial methods and materials for teaching reading; use of diagnostic instruments and interpretation of test results. Students participate in laboratory/field experience and prepare case studies with summary of diagnosis emphasizing remediation procedures. *Prq:* EDLT 860, 861, or 864.

EDLT 866 Practicum in Reading 3(2,2) Supervised practicum emphasizing diagnostic and remedial work with readers in public schools. *Prq:* EDLT 865, consent of instructor.

EDLT 867 Middle School Reading 3(3,0) Techniques, materials and theories for teaching reading to middle school students emphasizing correlating reading skills into the content area. *Prq:* Education major or consent of instructor.

EDLT 868 Using Literature and Technology for Reading Instruction 3(3,3) 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.

EDLT 869 Integrated Approach to Reading and Writing Instruction 3(3,0) Understanding of the reading/writing processes for early childhood and elementary teachers; investigation of the whole language approach in the classroom. *Prq:* EDLT 861 or equivalent.

EDLT 870 Early Literacy: Strategic Reading and Writing Instruction 3(3,0) Use of the theoretical base of the Reading Recovery program to modify instructional practices to include generalizable instructional procedures. *Prq:* EDLT 860 or equivalent.

EDLT 871 Literacy Across the Curriculum 3(3,0) Use of the theoretical base of the Reading Recovery program to modify instructional practices to include reading and writing activities in all aspects of K-5 curriculum. *Prq:* EDLT 860 or equivalent and 870.

EDLT 872 Guided Reading and Guided Writing 3(3,0) Use of the techniques of Guided Reading, Shared Writing, and Interactive Writing appropriately in classroom situations. Demonstration of 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. *Prq:* EDLT 860 or equivalent and 871.

EDLT 873 Models for Balanced Literacy 3(3,0) Prepares classroom teachers to organize K-5 classrooms for balanced literacy instruction. Participants apply classroom organization procedures in actual K-5 classrooms. *Prq:* EDLT 860 or equivalent, 865, and 872.

EDLT 874 Principles and Strategies for Teaching English Speakers of Other Languages 3(3,0) Helps participants develop culturally and linguistically responsive classrooms with instructional strategies for teaching the language acquisition process within the context of academics supportive of English language learners (ELLs) and their learning needs. *Prq:* Graduate standing in Education or consent of instructor.

EDLT 880 Reading Recovery Teacher I 3(3,0) First in a two-semester, two-course sequence designed to prepare teachers to implement and teach a Reading Recovery Program. Issues related to reading theory and process, instructional processes, program implementation and evaluation. *Prq:* Consent of instructor. *Coreq:* EDLT 882.

EDLT 881 Reading Recovery Teacher II 3(3,0) Second in a two-course sequence designed to prepare teachers to implement and teach in a Reading Recovery Program. Issues related to reading theory and process, instructional process, program implementation and evaluation. *Prq:* Admission into the Clemson Reading Recovery Program, EDLT 880, 882. *Coreq:* EDLT 883.

EDLT 882 Reading Recovery Teacher Practicum I 3(0,9) Teaching experience allowing teachers to develop and practice responsibilities of implementing and teaching first grade children in a Reading Recovery program. Participants implement content studied in EDLT 880. *Prq:* Consent of instructor. *Coreq:* EDLT 880.

EDLT 883 Reading Recovery Teacher Practicum II 3(0,9) Teaching experience and practice in implementing and teaching in a Reading Recovery Program. Participants implement content studied in EDLT 881. *Prq:* Admission into the Clemson University Reading Recovery Program, EDLT 880, 882. *Coreq:* EDLT 881.

EDLT 884 Reading Recovery Clinical I 3(3,0) First in a two-course sequence aimed at providing leadership experiences in implementing a Reading Recovery Program in an elementary school setting. *Prq:* Admission into the Clemson University Reading Recovery Teacher Leader program. *Coreq:* EDLT 886, 937.

EDLT 885 Reading Recovery Clinical II 3(3,0) Second in a two-course sequence to provide leadership experiences in implementing a Reading Recovery Program in an elementary school setting. *Preq:* Admission into the Clemson University Reading Recovery Teacher Leader program. *Coreq:* EDLT 887, 938.

EDLT 886 Reading Recovery Teacher Leader Practicum I 3(0,9) 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. *Preq:* Admission into the Clemson University Reading Recovery Teacher Leader program. *Coreq:* EDLT 884, 937.

EDLT 887 Reading Recovery Teacher Leader Practicum II 3(0,9) 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. *Preq:* Admission into the Clemson University Reading Recovery Teacher Leader program. *Coreq:* EDLT 885, 938.

EDLT 937 Reading Recovery Theory I 3(3,0) 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. *Preq:* Consent of instructor. *Coreq:* EDLT 884, 886.

EDLT 938 Reading Recovery Theory II 3(3,0) 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. *Preq:* Consent of instructor. *Coreq:* EDLT 885, 887.

EDLT 939 Theoretical Models of Reading 3(3,0) Psychological basis of the reading process; principles applied in teaching reading. *Preq:* EDLT 860 or 861 or consent of instructor.

EDLT 940 Advanced Diagnosis and Remediation in Reading 3(2,3) Advanced diagnosis and remediation in reading; review of diagnostic instruments and instructional materials. *Preq:* EDLT 860 or 861; 865; or consent of instructor.

EDLT 941 Advanced Practicum in Reading 3(2,3) Diagnosis and remediation testing; remediation. Extensive case studies with recommendation for the classroom teacher are required. *Preq:* EDLT 940 and consent of instructor.

EDLT 942 Teaching Reading Through a Literature Emphasis 3(3,0) Strategies for integrating literature into the traditional reading program. *Preq:* An introductory reading class or equivalent.

EDLT 943 The Reading-Writing Connection: An Integrated Approach 3(3,0) 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. *Preq:* Basic reading methods course.

EDLT 944 Reading Research: Review and Critique of the Literature 3(3,0) Historical and contemporary research in reading and related literacy fields. *Preq:* Admission to the PhD program in Curriculum and Instruction.

EDLT 945 Special Problems in Reading Education 3(1,4) Individual study of a specific topic in reading. Students may choose from a large diversity of topics. *Preq:* EDLT 860 or 861; EDLT 862, 865, ED F 808; or consent of instructor.

M B A

See courses listed under Business Administration.

MANAGEMENT

MGT 803 Operations Management 3(3,0) Introduction to a broad range of operations management topics. Serves as a foundation for understanding the importance, relevance and significance of analytical models and tools to be introduced in subsequent courses in the MS in Management program. Topics include operations strategy, process and facility design, planning and control, quality management, and continuous improvement. Offered fall semester only.

MGT 804 Operations Strategy 3(3,0) In-depth study, through case studies and readings, of the role operations systems capabilities play in providing sources of competitive advantage. Topics include industry analysis, technological forecasting, formulation of organization and operations strategies, and development of operations system capabilities. *Preq:* MGT 803 or consent of instructor. Offered fall semester only.

MGT 806 Industrial Management Internship 0 Faculty-approved internship to give MS in Management students on-the-job learning in support of classroom education. Internships must be at least six, full-time, consecutive weeks with the same internship provider. May be repeated. *Preq:* Consent of graduate coordinator.

MGT 807 Comparative Management Theory 3(3,0) 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.

MGT 808 Manufacturing Planning and Control Systems 3(3,0) 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. Offered spring semester only. *Preq:* MGT 803 or consent of instructor.

MGT (M B A) 809 Organizational Behavior and Human Resources Management 3(3,0) See M B A 809.

MGT 812 Supply Chain Management 3(3,0) 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. Offered fall semester only. *Preq:* Consent of instructor.

MGT 815 Personnel Management 3(3,0) Personnel management activities including recruitment, selection, training and development, performance appraisal, discipline, grievance handling, wage and salary administration, and employee benefit programs.

MGT 818 E-Commerce Web Site Development 3(2,1) Enabling information technologies for electronic commerce, including databases and Web applications. These technologies are applied to a project. *Preq:* Computer programming experience.

MGT 819 Web-Based Information Systems for Supply Chain Management 3(2,1) Examines system architectures, technologies, approaches and infrastructure requirements for supply-chain information systems. Students learn to design, develop and implement systems that facilitate collaboration of an enterprise with its buyers and suppliers. *Preq:* MGT 812 and 818 or consent of instructor.

MGT 820 Service Operations Management 3(3,0) Concepts and techniques of service operating system design and management. Topics include characteristics of services, service system performance measurement, queuing and automation, planning and control in different service environments, and international service operations. *Preq:* MGT 803 or consent of instructor.

MGT 821 Lean Operations 3(3,0) Examines uses of the scientific method, the Toyota Production System and the application of the appropriate tools and methods to design both service and production operations. Development of systems that promote lean operations is emphasized. *Preq:* M B A 806, M B A 856, or MGT 803 or consent of instructor.

MGT 822 International Operations Management 3(3,0) Operations management within an international business environment. Topics include the regulatory and cultural environment of international business, international business and operations strategies, global location, global sourcing and logistics decisions, international workforce management, technology transfer and configuration, and coordination of global operations activities. *Preq:* MGT 803 or consent of instructor.

MGT 823 Management Systems Analysis 3(3,0) 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.

MGT 824 Service Strategy: Design for Customer Experience 3(3,0) Multi-disciplinary approach to service design, considering the roles of customers and employees in creating experiences. Includes principles, frameworks and paradigms describing services design and management necessary to achieving a distinctive competitive advantage. Emphasizes development and execution of strategies that link operations and marketing. *Preq:* M B A 856 or consent of instructor.

MGT 829 Management of E-Commerce 3(3,0) 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. *Preq:* Consent of instructor.

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

MGT (M B A) 845 Technology and Innovation Management 3(3,0) See M B A 845.

MGT 850 Business Decision Models 3(3,0) 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. *Prreq:* Consent of instructor.

MGT 852 Management Science II 3(3,0) Continuation of MGT 850; dynamic, integer and nonlinear programming emphasizing applications of different types of mathematical programming to business and industrial problems. *Prreq:* MGT 850 or consent of instructor.

MGT 854 Design of Experiments in Business and Management 3(3,0) 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. Offered fall semester only.

MGT 856 Business Fundamentals for Supply Chain Management 3(3,0) Principles and techniques of leadership, human resources management, financial management, marketing and economic analysis, particularly as they relate to the capital projects supply chain management. *Prreq:* Enrollment in Master of Engineering Program in Industrial Engineering.

MGT (M B A) 861 Information Systems 3(3,0) See M B A 861.

MGT 866 System Analysis and Design 3(2,1) Software engineering methods and techniques specific to analysis and design of information systems. Topics include concepts and methods for valuation of IT applications, data gathering, and process, data and object-oriented modeling analysis and design.

MGT 869 Project Management 3(3,0) In-depth study, through case studies, readings and hands-on experience, of processes and techniques to initiate, plan, execute, control and close-out information technology projects. Topics include project integration, scope, time, cost, quality, human resource, communications, risk and procurement management. *Prreq:* Consent of instructor.

MGT (M B A) 874 Managing Continuous Improvement 3(3,0) See M B A 874.

MGT 885 Industrial Scheduling 3(3,0) Theoretical results for single and parallel machine, flow shop, job shop and network scheduling; treatment of mathematical programming applications, scheduling algorithm design and search procedures. *Prreq:* One of the following: C E 835, CP SC 840, I E 803, M B A 859, MGT 850, MTHSC 812 or 814; and consent of instructor.

MGT 888 International Perspectives in Industrial Management 1-6(1-6, 0) International perspective to industrial management via organized plant visitations to businesses in a foreign country and lectures by, and discussions with, senior operations managers. Cultural visits and lectures are also organized to provide a holistic perspective to cover cultural and economic development of the host country. May be repeated for a maximum of six credits. *Prreq:* Consent of instructor.

MGT 891 Master's Thesis Research 1-12

MGT 892 Master's Project Course 3(0,9) Field project, the capstone activity in the program, requiring application of the program body of knowledge to a real-world operations management problem. Formal presentation and written report are required. May be repeated for a maximum of 12 credits. To be taken Pass/Fail only. *Prreq:* Consent of instructor.

MGT 899 Selected Topics in Industrial Management 3(3,0) Current topics in industrial management theory and/or practice. Topics vary in keeping with developments in the management profession and interests of faculty. May be repeated for a maximum of nine credits.

MGT 903 Seminar in Manufacturing Planning and Control Systems 3(3,0) Current research issues and developments in manufacturing planning and control systems emphasizing research (philosophical, analytical and empirical) dealing with alternative approaches for planning and control of manufacturing operations. *Prreq:* MGT 808, consent of instructor.

MGT 904 Seminar in Current Management Topics 3(3,0) 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 credits. *Prreq:* MGT 803 or consent of instructor.

MGT 905 Research Methods 3(3,0) 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. Restricted to doctoral students. *Prreq:* MGT 854 or equivalent.

MGT 907 Seminar in the Design of Operations Systems 3(3,0) Current management issues and developments in the evaluation, selection, design and installation of systems for manufacturing and service operations; empirical research dealing with the building blocks of operations such as process technology scanning, selection and installation; operations systems location and layout; and management systems selection and installation. *Prreq:* MGT 821, consent of instructor.

MGT 910 Seminar in Operations Management 1-3(1-3,0) 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. *Prreq:* Consent of instructor.

MGT 916 Directed Readings in Management 1-3(1-3,0) Directed reading and research in the student's area of interest. May be repeated for a maximum of three credits. *Prreq:* Consent of instructor.

MGT 918 Seminar in Management Support Systems 3(3,0) Contemporary topics in decision-oriented information systems research; structure of the field, research methodologies and research opportunities. *Prreq:* MGT 818 or consent of instructor.

MGT 925 Seminar on Information Systems Foundations 3(3,0) Foundations of information systems research including classical framework literature. Research philosophies, key methodologies and relevant theoretical underpinnings are discussed and debated.

MGT 927 Seminar in Organizational Impacts of Information Systems 3(3,0) Current theoretical and empirical research related to the organizational impacts of information systems. Research focuses on strategic and structural impacts of information technologies within and across organizations.

MGT 991 Doctoral Dissertation Research 1-12

MARKETING

MKT 623 Promotional Strategy 3(3,0) Emphasizes promotion as the communication function of marketing. Attention is given to communication theory and promotion's relation to mass and interpersonal communication. Factors affecting the promotional decision-making process are explored and promotion as a competitive tool is examined. *Prreq:* MKT 301 or consent of instructor.

MKT 627 International Marketing 3(3,0) Study of marketing from the international point of view. Emphasis is on the necessary modification of marketing thinking and practice for foreign markets due to individual environmental differences. *Prreq:* MKT 301.

MKT 628 Services Marketing 3(3,0) Exploration and study of the nature of service organizations and the principles that guide the marketing of their products. Emphasis is on a marketing mix that is fundamentally different than that found in traditional goods marketing. *Prreq:* MKT 301 or consent of instructor.

MKT 629 Public and Nonprofit Marketing 3(3,0) Examines the role and application of marketing in public and nonprofit settings. Focuses on a conceptual understanding of the marketing discipline and marketing processes and shows how basic concepts and principles of marketing are applicable to public and nonprofit organizations. *Prreq:* MKT 301 or consent of instructor.

MKT 630 Marketing Product Management 3(3,0) 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 and others. Emphasis is on decision making. *Prreq:* MGT 310, MKT 301; or consent of instructor.

MKT 695 Selected Topics 3(3,0) In-depth examination of timely topics in marketing. May be repeated for credit, but only if different topics are covered. *Prreq:* MKT 301 or consent of instructor.

MKT 826 Business Marketing 3(3,0) Strategic marketing as it applies to industrial, organizational and institutional markets; consumer marketing versus business-to-business marketing; current business marketing literature and practices. *Prreq:* Principles of marketing or equivalent or consent of instructor.

MKT 828 Services Marketing 3(3,0) 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. *Preq:* Principles of marketing or equivalent or consent of instructor.

MKT 860 Advanced Marketing Strategy 3(3,0) Advanced marketing theory and critical thinking skills applied to support strategic decision making. Data analysis and advanced marketing models are employed with emphasis on building analytic and assessment skills. Offered spring semester only. *Preq:* M B A 858 or MKT 865 or consent of instructor.

MKT 861 Marketing Research 3(3,0) Marketing theory and critical thinking to support decision making; data analysis and advanced marketing models are employed with emphasis on building assessment skills. Primary topics are gathering primary and secondary data, questionnaire design, sampling, experimental design, data collection and data analysis. *Preq:* Enrollment in MS in Marketing or MKT 860 or consent of instructor.

MKT 862 Quantitative Methods in Marketing 3(3,0) Advanced quantitative analytic methods and their use in translating facts into meaningful information. Provides practical understanding of several advance quantitative data analytic procedures including both predictive and interdependence techniques. Application to case analysis format to broaden analysis skills. *Preq:* MKT 861 or consent of instructor.

MKT 863 Buyer Behavior 3(3,0) Buyer decision processes in the purchase and consumption of goods and services by both businesses and consumers. Topics include economic, sociocultural and psychological aspects of buying behavior; decision-making processes and buyer choice; individual and group level influences on consumer behavior; and implications of consumer behavior for marketers. *Preq:* Enrollment in MS in Marketing or MKT 860 or consent of instructor.

MKT 865 Seminar in Marketing Management 3(3,0) Current research and practice in components of marketing management. In-depth discussion of marketing mix variables, segmentation, targeting and positioning, and budget-related issues. *Preq:* Enrollment in MS in Marketing.

MKT 866 Selected Topics in Marketing 3(3,0) Current topics in marketing theory and research. Topics vary with developments in the marketing profession. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* MKT 860 or 865 or consent of instructor.

MKT 870 Master's Research Project 1-9 Student development and participation in research. Application to a current business problem or development of new research. Formal presentation and written report are required. May be repeated for a maximum of nine credits. *Preq:* Enrollment in MS in Marketing and consent of graduate advisor.

MASTER OF BUSINESS ADMINISTRATION (MBA)

See courses listed under Business Administration.

MATERIALS SCIENCE AND ENGINEERING

MS&E 602 Solid State Materials 3(3,0) Discussion of the properties of solids as related to structure and bonding with emphasis on electronic materials. Band structure theory, electronic, and optical properties are treated. *Preq:* MS&E 326, MTHSC 208, PHYS 221.

MS&E 613 Noncrystalline Materials 3(3,0) Study of the fundamentals of the noncrystalline state. Includes cooling kinetics and effects on formation, as well as physical properties of noncrystalline substances in metallic, polymeric, and ceramic systems. *Preq:* MS&E 326; *Coreq:* MS&E 402; or consent of instructor.

MS&E 615 Introduction to Polymer Science and Engineering 3(3,0) Chemistry of monomers and polymers and the chemical and physical properties of polymers are discussed emphasizing fiber forming, synthetic polymers. Includes molecular characterization, structure, morphology, and mechanical properties as they relate to the design of polymer systems for end uses in textiles, geotextiles, plastics and fiber-reinforced composite materials. *Preq:* CH 201 and 330 or 224, or consent of instructor.

MS&E 616 Electrical Properties of Materials 3(3,0) Covers a range of topics dealing with electrical and magnetic materials, including metal and polymer conductors, insulators, ceramic and polymer materials for dielectric applications, and ferroelectric, piezoelectric, pyroelectric, and electrooptic materials. Metal and ceramic magnetic materials are also discussed.

MS&E 622 Mechanical Behavior of Materials 3(3,0) Covers the microstructural basis of deformation and fracture in ceramic, metallic, and polymeric systems. *Preq:* C E 201, MTHSC 208 or consent of instructor.

MS&E 624 Optical Materials and Their Applications 3(3,0) Introduces the interaction of materials with light. Specific topics include fundamental optical properties, materials synthesis, optical fiber and planar waveguides, and the componentry and systems-level aspects of optical communication systems. *Preq:* MS&E 402, 413.

MS&E 656 Polymer and Fiber Science II 3(2,3) 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.

MS&E 657 Color Science 3(3,0) Understanding of physical, chemical, and mechanical principles behind the application of colors and finishes to textiles. Requires an appreciation of fiber chemistry and morphology, dye and finish structures and reactivity and mechanical principles behind equipment used to effect transfer of these chemicals onto the textile substrate.

MS&E 658 Surface Phenomena in Materials Science and Engineering 3(3,0) Introduction to surface phenomena focusing on fiber science. Fundamentals of interfacial phenomena embrace thermodynamics of surfaces, physics of adhesion, wetting, and finishing emphasizing specific features associated with interactions of liquids and chemicals with fibers and fibrous materials. *Preq:* Junior standing in engineering or science.

MS&E 662 Properties of Textile Structures 3(2,2) Yarn and fabric properties, their scientific significance and analysis. Dimensional, structural, and mechanical interrelationships are established and evaluated.

MS&E 664 Nonwoven Structures 3(2,2) Nonwoven fabric structures, their manufacture, properties, and applications. Methods of nonwoven fabric formation, resultant material characteristics and end-use applications are examined. *Preq:* MS&E 201.

MS&E 690 Selected Topics in Materials Science and Engineering 1-3(1-3,0) Study of topics not ordinarily covered in 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. *Preq:* Consent of instructor.

MS&E 800 Seminar in Materials Research 1(1,0) Special topics and original research in materials science, materials engineering, and polymer and fiber chemistry. To be taken Pass/Fail only.

MS&E 801 Graduate Student Seminar in Materials Research 1(1,0) Presentation of individual graduate student research topics in Materials Science and Engineering. *Preq:* MS&E 800.

MS&E 809 High-Temperature Materials 3(3,0) Properties of oxides, carbides, nitrides, borides and silicides; obtainment and measurement of high temperatures; measurement of properties at high temperatures.

MS&E 815 Colloidal and Surface Science 3(3,0) Theory and application of colloidal and surface chemistry to ceramic materials and processes.

MS&E 816 Constitution and Structure of Glasses 3(3,0) Modern concepts of glass structure and properties.

MS&E 819 X-Ray Diffractometry 3(2,3) Theory and application of powder X-ray diffractometry to ceramic and materials problems.

MS&E 820 Deformation Mechanisms in Solids 3(3,0) Dislocation theory of solids; mechanisms of plastic deformation in single crystals and polycrystalline aggregates of metals and nonmetals; ductile and brittle fractures; fatigue, creep and stress corrosion cracking of metals. *Preq:* Consent of instructor.

MS&E 821 Fracture and Fatigue 3(3,0) Investigation into stress-strain-time relations in elasticity, plasticity and rupture showing effects of high- and low-temperature structures. *Preq:* MS&E 820 or consent of instructor.

MS&E 822 Scanning Electron Microscopy 3(2,3) Theory and application of scanning electron microscopy to ceramic and materials problems.

MS&E 823 Transmission Electron Microscopy 3(2,3) Advanced course in electron microscopy for materials science incorporating all aspects of transmission techniques: basics, diffraction, imaging and spectrometry. *Preq:* MS&E 821 and 822 or consent of instructor.

MS&E 824 Magnetic and Electrical Ceramic Materials 3(3,0) Application of magnetic and electrical theory to ceramic insulators, semiconductors, and ferroelectric and ferromagnetic products.

MS&E 825 Solid State Materials Science 3(3,0) Bonding and structure of crystalline materials as related to mechanical, thermal and chemical properties of solids.

MS&E 826 Phase Equilibria in Materials Systems 3(3,0) Advanced treatment of phase equilibria in materials systems, phase diagrams, thermodynamics of defects, surfaces, interfaces and solutions. *Preq:* MS&E 210; consent of instructor. *Coreq:* M E 810.

MS&E 827 Kinetics of Phase Transformation 3(3,0) Advanced treatment of the kinetics of phase transformation in materials systems including nucleation, growth and spinodal decomposition. *Preq:* MS&E 826 or equivalent, consent of instructor.

MS&E 828 Phase Transformations in Materials Science 3(3,0) Advanced treatment of gas-solid, gas-liquid, liquid-solid and solid-solid transformations in materials systems. *Preq:* MS&E 827.

MS&E 840 Analytical Methods in Textile and Polymer Science 4(3,3) 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. Offered spring semester only. *Preq:* Consent of instructor.

MS&E 851 Polymer Science I 3(3,0) Fundamentals of polymer chemistry. Chemistry and synthesis of monomers and polymers in relation to thermodynamics, kinetics and mechanisms of polymerization reactions emphasizing fiber-forming polymers, plastics and composite matrix materials. Offered fall semester only.

MS&E 852 Polymer Science II 3(3,0) Chemical structure and properties of polymers. Polymer solution properties, the viscoelastic state and the crystalline morphology of polymeric materials. Current theories for describing polymer thermal transitions, molecular weight, molecular weight distributions and transport phenomena in polymeric systems, as well as interfacial phenomena. Offered spring semester only.

MS&E 854 Multicomponent Polymeric Materials 3(3,0) Principles of advanced multicomponent polymeric materials and systems based on the following topics: different polymer-polymer and polymer-nonpolymer combinations; multicomponent materials synthesis, fabrication, properties and applications; modification and instrumental characterization of polymer surfaces and interfaces; functional coatings, nanocomposites, adhesives, nanodevices, polymer blends and composites, interpenetrating polymeric networks and block-copolymers. *Preq:* Introductory polymer course or consent of instructor.

MS&E 861 Fiber Physics I 3(3,0) Fiber physical properties and their relationship to fiber structure; methods of investigating fiber structure and physical properties; theories of viscoelastic behavior and thermal properties; models of fiber structure. Offered fall semester only.

MS&E 862 Fiber Physics II 3(3,0) Extension of MS&E 861, 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. Offered spring semester only. *Preq:* MTHSC 208 and MS&E 861 or consent of instructor.

MS&E 866 Fiber Formation 3(3,0) Formation of fibers by wet, dry and melt spinning are studied in depth with emphasis on rheology of solutions and melts, fiber structure, stretching and drawing processes and the interrelationships of polymer properties and processes that determine fiber properties. Offered spring semester only.

MS&E 890 Selected Topics in Materials Science and Engineering 1-3(1-3,0) 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 a maximum of six credits. *Preq:* Consent of instructor.

MS&E 891 Master's Thesis Research 1-12

MS&E 991 Doctoral Dissertation Research 1-12

MATHEMATICAL SCIENCES

MTHSC 600 Theory of Probability 3(3,0) Principal topics include 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. *Preq:* MTHSC 206 or consent of instructor.

MTHSC 603 Introduction to Statistical Theory 3(3,0) Principal topics include 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, introduction to analysis of variance. *Preq:* MTHSC 400 or equivalent.

MTHSC 605 Statistical Theory and Methods II 3(3,0) Principal topics include 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. *Preq:* MTHSC 301.

MTHSC 606 Sampling Theory and Methods 3(3,0) Probability-based treatment of sampling methodology. Theory and application of estimation techniques are treated using simple and stratified random sampling, cluster sampling and systematic sampling. *Preq:* MTHSC 302 and 400, or consent of instructor.

MTHSC 607 Regression and Time Series Analysis 3(3,0) Theory and application of the regression and time series. Approaches to empirical model building and data analysis are treated. Computation and interpretation of results are facilitated through the use of interactive statistical packages. *Preq:* MTHSC 302, 311, 400; or consent of instructor.

MTHSC 608 Topics in Geometry 3(3,0) Introduction to topics in special geometries which include non-Euclidean space concepts such as projective geometry, finite geometries and intuitive elementary topology. Brief introduction to vector geometry. *Preq:* MTHSC 206.

MTHSC 612 Introduction to Modern Algebra 3(3,0) Introduction to the concepts of algebra. Topics include the number system and the elementary theory of groups, rings and fields. *Preq:* MTHSC 311.

MTHSC 619 Discrete Mathematical Structures I 3(3,0) Applies theoretical concepts of sets, functions, binary relations, graphs, Boolean algebras, propositional logic, semigroups, groups, homomorphisms and permutation groups to computer characteristics and design, words over a finite alphabet and concatenation, binary group codes and other communication or computer problems. *Preq:* MTHSC 311.

MTHSC 634 Advanced Engineering Mathematics 3(3,0) Fourier series, Laplace and Fourier transform and numerical methods for solving initial value and boundary-value problems in partial differential equations are developed. Applications to diffusion wave and Dirichlet problems are given. Matrix methods and special functions are utilized. *Preq:* MTHSC 208.

MTHSC 635 Complex Variables 3(3,0) Elementary functions; differentiation and integration of analytic functions; Taylor and Laurent series; contour integration and residue theory; conformal mapping; Schwarz-Christoffel transformation. *Preq:* MTHSC 206.

MTHSC 640 Linear Programming 3(3,0) Introduction to linear programming covering the simplex algorithm, duality, sensitivity analysis, network models, formulation of models and the use of simplex codes to solve, interpret and analyze problems. *Preq:* MTHSC 206, 311, or consent of instructor.

MTHSC 641 Introduction to Stochastic Models 3(3,0) Introductory treatment of stochastic processes, finite-state Markov chains, queueing, dynamic programming, Markov decision processes, reliability, decision analysis and simulation. Both theory and applications are stressed. *Preq:* MTHSC 400.

MTHSC 653 Advanced Calculus I 3(3,0) Limits, continuity and differentiation of functions of one and several variables, the Riemann integral, and vector analysis. *Preq:* MTHSC 206.

MTHSC 654 Advanced Calculus II 3(3,0) Continuation of MTHSC 653. Transformations, multiple integrals, line and surface integrals, infinite sequences and series and improper integrals. *Preq:* MTHSC 453.

MTHSC 660 Introduction to Numerical Analysis I

3(3,0) Introduction to the problems of numerical analysis emphasizing computational procedures and application. Topics include sources of error and conditioning, matrix methods, systems of linear equations, nonlinear equations, interpolation and approximation by splines, polynomials and trigonometric functions. *Preq:* MTHSC 206 or 207 and 360 or equivalent.

MTHSC 663 Mathematical Analysis I **3(3,0)** 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. *Preq:* MTHSC 206.**MTHSC 706 Probability and Statistics for Middle Grades Teachers** **3(3,0)** Topics include organizing, classifying and summarizing data; univariate and bivariate graphical techniques; measures of center and dispersion; correlation and simple regression; elementary probability theory, counting and simulations; binomial and normal distributions. A graphing calculator is used. *Preq:* Graduate standing in Middle Grades Education.**MTHSC 709 Geometry for the Middle Grades** **3(3,0)** Hands-on approach to constructions with straight-edge and compass; polygons including tessellations and polyhedra; symmetry and transformational geometry; coordinate geometry measurement with dimensional analysis; perspective drawing and related topics; history of geometry; reasoning and informal proof with congruence; and computer software, calculator use and Internet.**MTHSC 713 Algebra for Middle Grades Teachers** **3(3,0)** Study of elementary algebra, solution of equations, and inequalities; properties and applications of linear, quadratic, polynomial and exponential functions and models; graphical analysis and curve-fitting of real-world data; systems of equations and basic matrix operations. A graphing calculator is used. *Preq:* Graduate standing in Middle Grades Education.**MTHSC 714 Foundations of Mathematics for Middle Grades Teachers** **3(3,0)** Topics include logic, set theory, numeration systems; arithmetic operations and their properties on the integer, rational and real number systems; decimals, ratio, proportion, percent, exponents and roots. Includes an introduction to algebra and counting, permutations and combinations. *Preq:* Graduate standing in Middle Grades Education.**MTHSC 738 Modern Geometry for Secondary Teachers** **3(3,0)** Concepts of Euclidean geometry reviewed and extended by means of coordinates, vectors, matrices; conic sections. *Preq:* Enrollment in Secondary Education graduate program.**MTHSC 740 Linear Programming for Secondary Teachers** **3(3,0)** Development of mathematical theory of simplex algorithm; survey of mathematical background; matrix algebra, systems of linear equations and vector spaces; problem formulation is emphasized. *Preq:* Enrollment in Secondary Education graduate program.**MTHSC 749 Discrete Mathematics for Secondary Teachers** **3(3,0)** Discrete mathematics emphasizing applications to computer science; propositions and logic; Boolean Algebra and switching circuits; recursion and induction; relations and partially ordered sets, graphs and trees.**MTHSC 750 Modern Algebra for Secondary Teachers** **3(3,0)** Introduction to the fundamental concepts and historical development of abstract algebra. Topics include integers, binary operations, functions, equivalence, relations, permutations, groups, polynomials, commutative rings, integral domains, and fields. *Preq:* MTHSC 311 or 753, Graduate standing in Secondary Education.**MTHSC 753 Matrix Algebra for Secondary Teachers** **3(3,0)** Matrices and systems of equations; determinants; vector spaces and linear transformations; eigenvalues. *Preq:* Graduate standing in Secondary Education.**MTHSC 755 Combinatorial Analysis for Secondary Teachers** **3(3,0)** Permutations; combinations; generating functions; recurrence relations; principle of inclusion-exclusion; partitions; Latin squares; block designs; finite geometries; graphs; codes; Polya's theorem; recreational mathematics. *Preq:* Graduate standing in Secondary Education.**MTHSC 756 Applied Modern and Linear Algebra for Secondary Teachers** **3(3,0)** Various applied problems whose solutions rely on techniques and results of linear and modern algebra. Problems are selected from such areas as economics, forest management, genetics, population growth, transportation networks, cryptography, satellite communications, electronic switching circuits, chemistry, physics, sociology and others. *Preq:* MTHSC 721 or equivalent or consent of instructor.**MTHSC 758 Number Theory for Secondary Teachers** **3(3,0)** Topics include properties of integers, divisors and prime numbers; fundamental properties of congruence; polynomials and primitive roots; quadratic residues. *Preq:* Graduate standing in Secondary Education.**MTHSC 775 AP Statistics Institute** **3(3,0)** Topics include probability, conditional probability, descriptive statistics, random variables, probability functions, binomial distribution, normal distribution, sampling, estimation, decision making. *Preq:* Graduate standing in Secondary Education.**MTHSC 777 AP Calculus Institute** **3(3,0)** 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 780 Probability Theory for Secondary Teachers** **3(3,0)** Calculus-based introduction to basic ideas in probability theory. Topics include basic counting techniques, fundamental axioms of probability, conditional probability, discrete and continuous distributions, and sampling distributions. Emphasizes real-world applications and the use of simulations to illustrate concepts. *Preq:* MTHSC 108, Graduate standing in Secondary Education.**MTHSC 785 Data Analysis for Secondary Teachers**

3(3,0) Topics include data types, basic sampling and experimental designs, one- and two-sample confidence intervals and hypothesis tests, analysis of variance, model building with simple and multiple linear regression, and contingency tables. Includes a brief review of probability. Student groups propose and implement a real-world research project. *Preq:* MTHSC 301, 400, 600, or 780; Graduate standing in Secondary Education.

MTHSC 791 Selected Topics in Mathematics Education **1-3(1-3,0)** Mathematical problems in elementary or secondary school curricula. May be repeated for credit, but only if different topics are covered. *Preq:* Graduate standing in Elementary or Secondary Education.**MTHSC 800 Probability** **3(3,0)** Study of 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. Offered fall semester only. *Preq:* MTHSC 206.**MTHSC 801 General Linear Hypothesis I** **3(3,0)** Topics include 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. Offered fall semester only. *Preq:* MTHSC 311, 403.**MTHSC 802 General Linear Hypothesis II** **3(3,0)** Continuation of MTHSC 801. Offered spring semester only.**MTHSC 803 Stochastic Processes** **3(3,0)** Theory and analysis of time series, recurrent events, Markov chains, random walks, renewal theory, application to communication theory and operations research. *Preq:* MTHSC 400 or 800.**MTHSC 804 Statistical Inference** **3(3,0)** 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; model building. Offered fall semester only. *Preq:* MTHSC 400 or equivalent or consent of instructor.**MTHSC 805 Data Analysis** **3(3,0)** 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. *Preq:* MTHSC 301, 400.**MTHSC 806 Nonparametric Statistics** **3(3,0)** 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. Offered spring semester only. *Preq:* MTHSC 600 or 800.

MTHSC 807 Applied Multivariate Analysis 3(3,0)

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; principal components analysis; factor analysis; analytic rotations; canonical correlations. Offered fall semester only. *Preq:* MTHSC 403 and 805 or consent of instructor.

MTHSC 808 Reliability and Life Testing 3(3,0)

Probability models and statistical methods relevant to parametric and nonparametric analysis of reliability and life testing data. Offered spring semester only. *Preq:* MTHSC 400 or equivalent.

MTHSC 809 Time Series Analysis, Forecasting and Control 3(3,0)

Modeling and forecasting random processes; autocorrelation functions and spectral densities; model identification, estimation and diagnostic checking; transfer function models; feedforward and feedback control schemes. Offered spring semester only. *Preq:* MTHSC 605; 600 or 800; or equivalent.

MTHSC 810 Mathematical Programming 3(3,0)

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. *Preq:* MTHSC 311.

MTHSC 811 Nonlinear Programming 3(3,0)

Theoretical development of nonlinear optimization with applications, classical optimization, convex and concave functions, separable programming, quadratic programming and gradient methods. Offered spring semester only. *Preq:* MTHSC 440, 454.

MTHSC 812 Discrete Optimization 3(3,0)

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. Offered fall semester only. *Preq:* MTHSC 810 or equivalent.

MTHSC 813 Advanced Linear Programming 3(3,0)

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. Offered spring semester only. *Preq:* MTHSC 440, 810 or equivalent.

MTHSC 814 Network Flow Programming 3(3,0)

Max-flow/min-cut theorem, combinatorial applications, minimum cost flow problems (transporation, shortest path, transhipment), solution algorithms (including the out-of-kilter), and implementation and computational considerations. Offered fall semester only. *Preq:* MTHSC 440, 810 or equivalent.

MTHSC 816 Network Algorithms and Data Structures 3(3,0) 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. Offered spring semester only. *Coreq:* MTHSC 640, 810, 854, 863 or consent of instructor.

MTHSC 817 Stochastic Models in Operations Research I 3(3,0)

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. Offered spring semester only. *Preq:* MTHSC 803.

MTHSC 818 Stochastic Models in Operations Research II 3(3,0)

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. Offered fall semester only. *Preq:* MTHSC 817.

MTHSC 819 Multicriteria Optimization 3(3,0)

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. Offered fall semester only. *Preq:* MTHSC 810 or equivalent.

MTHSC 820 Complementarity Models 3(3,0)

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. Offered spring semester only. *Preq:* MTHSC 810.

MTHSC 821 Linear Analysis 3(3,0)

Normed spaces; Hilbert spaces, Banach spaces, linear functionals, linear operators, orthogonal systems. Offered spring semester and summer session only. *Preq:* MTHSC 454 or 453 and 853.

MTHSC 822 Measure and Integration 3(3,0)

Rings and algebras of sets, inner and outer measures; measurability and additivity, examples on the line and in space, Lebesgue integration, types of convergence, Lebesgue spaces; integration and differentiation, product measure, Fubini theorem. Offered fall semester only. *Preq:* MTHSC 454.

MTHSC 823 Complex Analysis 3(3,0)

Topological concepts; complex integration; local and global properties of analytic functions; power series; representation theorems; calculus of residues. Designed for nonengineering majors.

MTHSC 825 Introduction to Dynamical Systems 3(3,0)

Theory 3(3,0) Techniques of analysis of dynamical systems; sensitivity analysis, linear systems, stability and control; theory of differential and difference equations. Offered fall semester only. *Preq:* MTHSC 454 and 311 or 453 and 853.

MTHSC 826 Partial Differential Equations 3(3,0)

First-order equations: elliptic, hyperbolic and parabolic. Second-order equations: existence and uniqueness results, maximum principles, finite difference and Hilbert Space methods. Offered fall semester only. *Preq:* MTHSC 821 or consent of instructor.

MTHSC 827 Dynamical System Neural Networks 3(3,0)

Modeling problems in the context of dynamical systems theory; useful methods from Lyapunov stability, local linearization, qualitative analysis using graph theory and numerical approximations; several dynamical systems neural networks including binary code recognizers and binary matrix choosers. *Preq:* MTHSC 206, 311.

MTHSC 831 Fourier Series 3(3,0)

MTHSC 854 Theory of Graphs 3(3,0) Connectedness; path problems; trees; matching theorems; directed graphs; fundamental numbers of the theory of graphs; groups and graphs. Offered spring semester only. *Preq:* Consent of instructor.

MTHSC 855 Combinatorial Analysis 3(3,0) Combinations; permutations; permutations with restricted position; Polya's theorem; principle of inclusion and exclusion; partitions; recurrence relations; generating functions; Möbius inversion; enumeration techniques; Ramsey numbers; finite projective and affine geometries; Latin rectangles; orthogonal arrays; block designs; error detecting and error correcting codes. Offered fall semester only. *Preq:* MTHSC 311.

MTHSC 856 Theory of Error-Correcting Codes 3(3,0) Topics include code constructions such as Hammig, cyclic, BCH, Reed-Solomon, Goppa, algebraic geometry, finite geometry, low-density parity check, convolutional and polynomial codes; code parameters and bounds; and decoding algorithms. *Preq:* MTHSC 853 or consent of instructor.

MTHSC 857 Cryptography 3(3,0) Classical and modern cryptography and their uses in modern communication systems are covered. Topics include entropy, Shannon's perfect secrecy theorem, Advanced Encryption Standard (AES), integer factorization, RSA cryptosystem, discrete logarithm problem, Diffie-Hellman key exchange, digital signatures, elliptic curve cryptosystems, hash functions and identification schemes. *Preq:* MTHSC 311, 400 or 600, 412 or 851.

MTHSC 858 Number Theory 3(3,0) Covers topics and techniques from modern number theory including unique factorization, elementary estimates on the distribution of prime numbers, congruences, Chinese remainder theorem, primitive roots, n-th powers modulo an integer, quadratic residues, quadratic reciprocity, quadratic characters, Gauss sums and finite fields. *Preq:* MTHSC 853 or consent of instructor.

MTHSC 860 Introduction to Scientific Computing 3(3,0) 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. *Preq:* CP SC 110, MTHSC 208, 311.

MTHSC 861 Advanced Numerical Analysis I 3(3,0) Consideration of topics in numerical linear algebra: eigenvalue problems, the singular value decomposition, iterative algorithms for solving linear systems, sensitivity of linear systems, and optimization algorithms. *Preq:* MTHSC 311 and 460; or 860.

MTHSC 863 Digital Models I 3(3,0) Experimental mathematics; pseudostochastic 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. Offered fall semester only. *Preq:* MTHSC 311, 453, digital computer experience.

MTHSC 865 Data Structures 3(3,0) 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. Offered fall semester only. *Preq:* Computational maturity, consent of instructor.

MTHSC 866 Finite Element Method 3(3,0) Discusses the basic theory of the finite element method (FEM) for the numerical approximation of partial differential equations. Topics include Sobolev spaces, interpolation theory, finite element spaces, error estimation, and implementation of FEM in one and higher dimensions. *Preq:* MTHSC 860 or consent of instructor.

MTHSC 874 Integration through Optimization 3(3,0) Theory, methodology and applications of decomposition, integration and coordination for large-scale or complex optimization problems encountered in engineering design. Topics include conventional and non-conventional engineering optimization algorithms, analysis models and methods, multidisciplinary optimization, analytic target cascading, multiscenario optimization, and multicriteria optimization. Case studies are included. *Preq:* MTHSC 810, 860, or M E 871, or equivalent.

MTHSC 881 Mathematical Statistics 3(3,0) 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. Offered spring semester only. *Preq:* MTHSC 403 or equivalent.

MTHSC 884 Statistics for Experimenters 3(3,0) Statistical methods for students who are conducting experiments; introduction to descriptive statistics, estimation and hypothesis testing as they relate to design of experiments; higher-order layouts, factorial and fractional factorial designs, and response surface models. Offered fall semester only. *Preq:* MTHSC 206 or equivalent.

MTHSC 885 Advanced Data Analysis 3(3,0) Continuation of MTHSC 805 covering alternatives to ordinary least squares, influence and diagnostic considerations, robustness, special statistical computation methods. Offered spring semester only. *Preq:* MTHSC 603, 800, 805.

MTHSC 891 Master's Thesis Research 1-12

MTHSC 892 Master's Project Course 1(0,1) For students in the nonthesis option of the MS degree program in Mathematical Sciences. Successful completion includes a presentation of the master's project to the student's advisory committee and acceptance of the paper by the committee.

MTHSC 900 Seminar in Preparing for College Teaching in the Mathematical Sciences 3(3,0) Elements involved in being a college professor with emphasis on broadening the student's mathematical experiences within a framework of improving classroom performance. *Preq:* Completion of the departmental PhD qualifying examinations.

MTHSC 901 Probability Theory I 3(3,0) 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. *Preq:* MTHSC 400 and 822, or MTHSC 800 and 822 or consent of instructor.

MTHSC 902 Probability Theory II 3(3,0) 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. *Preq:* MTHSC 901.

MTHSC 927 Functional Analysis 3(3,0) Linear operators on specific spaces, spectral theory, semigroups of operators and the Hille-Yosida theorem, applications of linear spaces and operators, convexity. *Preq:* MTHSC 821.

MTHSC 951 Algebraic Number Theory 3(3,0) Covers arithmetic of number fields and number rings. Covers prime decomposition, ideal class groups, unit groups of number fields and distribution of prime ideals in number fields. Provides an overview of completions absolute values and valuation theory. *Preq:* MTHSC 851.

MTHSC 952 Analytic Number Theory 3(3,0) The theory of Fourier analysis and complex analysis are essential to modern number theory. Course focuses on applications of this theory to number theory, such as the proof of the prime number theorem and the connection of complex L-series to the distribution of primes and to arithmetic geometry. *Preq:* MTHSC 821 or consent of instructor.

MTHSC 954 Advanced Graph Theory 3(3,0) Continuation of MTHSC 854 including the four-color theorem, domination numbers, Ramsey theory, graph isomorphism, embeddings, algebraic graph theory and tournaments. Research papers are also examined. Offered fall semester only. *Preq:* MTHSC 854 or consent of instructor.

MTHSC 970 Directed Studies in Mathematical Sciences 1-3(1-3,0) Directed individual studies on topics in the mathematical sciences supervised by faculty. May be repeated for a maximum of 18 credits. *Preq:* Consent of instructor.

MTHSC 974 Selected Topics in Mathematical Sciences 3(3,0) Advanced topics in the mathematical sciences from current areas of interest presented in lecture format. May be repeated for a maximum 24 credits, but only if different topics are covered. *Preq:* Consent of instructor.

MTHSC 981 Selected Topics in Mathematical Statistics and Probability 1-3(1-3,0) Advanced topics in mathematical statistics and probability of current interest. May be repeated for credit, but only if different topics are covered.

MTHSC 982 Selected Topics in Analysis 1-3(1-3,0) Advanced analysis topics from current problems of interest. May be repeated for credit, but only if different topics are covered.

MTHSC 983 Selected Topics in Computational Mathematics 1-3(1-3,0) Advanced topics in computational mathematics and numerical analysis from current problems of interest. May be repeated for credit, but only if different topics are covered.

MTHSC 985 Selected Topics in Algebra and Combinatorics 1-3(1-3,0) 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(1-3,0) 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(1-3,0) Advanced topics in operations research from current problems of interest. May be repeated for credit, but only if different topics are covered.

MTHSC 989 Selected Topics in Mathematical Education 3(3,0) Advanced topics in the mathematical sciences from the area of mathematics education. May be repeated for credit, but only if different topics are covered. *Prq:* Consent of instructor.

MTHSC 991 Doctoral Dissertation Research 1-12

MECHANICAL ENGINEERING

ME 607 Applied Heat Transfer 3(3,0) Application-oriented extension of ME 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. *Prq:* M E 304, consent of instructor.

ME 617 Mechatronics System Design 3(2,3) Mechatronics integrates control, sensors, actuators and computers to create a variety of electromechanical products. Includes concepts of design, appropriate dynamic system modeling, analysis, sensors, actuating devices and real-time microprocessor interfacing and control. Laboratory experiments, simulation and design projects are used to exemplify course concepts. *Prq:* M E 305 or consent of instructor.

ME 620 Energy Sources and Their Utilization 3(3,0) Covers availability and use of energy sources such as fossil fuels, solar (direct and indirect) and nuclear. Addresses energy density and constraints to use (technical and economic) for each source. *Prq:* M E 303, 304.

ME 621 Introduction to Compressible Flow 3(3,0) 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. *Prq:* M E 303, 308.

ME 622 Design of Gas Turbines 3(3,0) Guiding principles in gas turbine cycles are reviewed. Turbine and compressor design procedures and performance prediction for both axial and radial flow machines are presented. Methods of design of rotary heat-exchangers and retrofitting gas turbine for regenerative operation are presented. Design projects are used to illustrate the procedures. *Prq:* M E 308.

ME 623 Introduction to Aerodynamics 3(3,0) Basic theories of aerodynamics for accurately predicting the aerodynamic forces and moments which act on a vehicle in flight. *Prq:* M E 308.

ME 629 Thermal Environmental Control 3(3,0) Mechanical vapor compression refrigeration cycles, refrigerants, thermoelectrical cooling systems, cryogenics, thermodynamic properties of air, psychometric charts, heating and cooling coils, solar radiation, heating and cooling loads, insulation systems. *Prq:* M E 303, 308.

ME 630 Mechanics of Composite Materials 3(3,0) Fundamental relationships for predicting the mechanical and thermal response of multilayered materials and structures are developed. Micromechanical and macromechanical relationships are developed for laminated materials with emphasis on continuous filament composites. The unique nature of composites and the advantages of designing with composites are discussed. *Prq:* M E 302.

ME 632 Advanced Strength of Materials 3(3,0) Topics in strength of materials not covered in M E 302. 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. *Prq:* M E 302.

ME 653 Dynamic Performance of Vehicles 3(3,0) Introduces techniques for analyzing the dynamic behavior of vehicles such as aircraft, surface ships, automobiles and trucks, railway vehicles and magnetically levitated vehicles. *Prq:* M E 305 or consent of instructor.

ME 654 Design of Machine Elements 3(3,0) Design of common machine elements including clutches, brakes, bearings, springs and gears. Optimization techniques and numerical methods are employed as appropriate. *Prq:* M E 306 or consent of instructor.

ME 655 Design for Manufacturing 3(3,0) Concepts of product and process design for automated manufacturing are considered. Topics include product design for automated manufacturing, inspection and assembly, using automation, industrial robots, knowledge-based systems and concepts of flexible product manufacture. *Prq:* M E 306, 312 (or concurrent enrollment), or consent of instructor.

ME 671 Computer-Aided Engineering Analysis and Design 3(2,3) Students are exposed to geometric and solid modeling, finite elements, optimization and rapid-prototyping. Students design an artifact, represent it on the computer, analyze it using FEA, then optimize before prototyping it. Emphasizes the use of computer-based tools for engineering design. *Prq:* ENGR 141, M E 202, or consent of instructor.

ME 693 Selected Topics in Mechanical Engineering 1-6(1-6,0) Study of topics not found in other courses. May be repeated for a maximum of six credits, but only if different topics are covered. *Prq:* Consent of instructor.

ME 801 Foundations of Fluid Mechanics 3(3,0) Derivations of basic equations for multidimensional flow fields; analytical techniques for solving problems in laminar viscous flow and laminar inviscid flow; theories of similitude. *Prq:* Consent of instructor.

ME 810 Macroscopic Thermodynamics 3(3,0) First, second and third laws of thermodynamics with engineering applications; thermodynamic property relations; chemical equilibrium. *Prq:* M E 312 or equivalent.

ME 811 Gas Dynamics 3(3,0) 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. *Prq:* Undergraduate course in fluid mechanics.

ME 812 Experimental Methods in Thermal Science 3(2,2) 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.

ME 814 Concepts of Turbulent Flow 3(3,0) 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. *Prq:* M E 801.

ME (PHYS) 815 Statistical Thermodynamics I 3(3,0) See PHYS 815.

ME 818 Introduction to Finite Element Analysis 3(3,0) 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. *Prq:* Numerical methods course or consent of instructor.

ME 819 Computational Methods in Thermal Sciences 3(3,0) Numerical techniques as applied to the solution of fluid flow and heat transfer problems; use of finite difference methods.

ME 820 Modern Control Engineering 3(3,0) State-space approach to analysis of linear dynamic systems and control design, state-space representation, key topics in linear algebra and vector spaces, principles of controllability, observability, stability and performance specification; trade-offs between state variable and transfer function techniques. Observer designs, pole placement and optimal control theory; LQR and Kalman filtering. *Prq:* M E 823 or an undergraduate controls course (e.g. M E 403) or consent of instructor.

ME 821 Advanced Control Engineering 3(3,0) Reviews topics from modern control engineering, characteristics of nonlinear systems. Phase Plane and Describing-Function techniques. Lyapunov theory and stability analysis; nonlinear feedback control systems using Lyapunov method. Advanced topics, variable structure system control, adaptive control-system analysis and design, robust adaptive control, optimal control and digital control. *Prq:* M E 820 or graduate-level course in modern control or consent of instructor.

ME 823 Control Systems Engineering 3(3,0) Physical modeling, mathematical analysis and feedback principles for control of multidisciplinary dynamic systems, including mechanical, electrical, electromagnetic, hydraulic and pneumatic systems. Transient response, root locus and frequency response principles applied to control of complex dynamic systems. Sensors, actuators and dynamic plant integration to develop, model, control and analyze dynamics systems. *Prq:* Undergraduate course on system dynamics or consent of instructor.

ME 829 Energy Methods and Variational Principles 3(3,0) Application of variational principles in solid mechanics problems; virtual work; Castiglano's theorems on deflection and rotation; stationary potential energy; energy stability criterion; Hamilton's principle. *Prreq:* M E 837 or consent of instructor.

ME 830 Conduction and Radiation Heat Transfer 3(3,0) 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. *Prreq:* M E 304 or equivalent.

ME 831 Convective Heat Transfer 3(3,0) Derivation of continuity, momentum, and energy equations for boundary layer flow; solutions for confined and external flow regimes in laminar and turbulent flow. *Prreq:* M E 304 or equivalent, MTHSC 208.

ME 832 Radiative Heat Transfer 3(3,0) 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. *Prreq:* M E 304 or equivalent, consent of instructor.

ME 833 Heat Transfer with Change of Phase 3(3,0) 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. *Prreq:* M E 304 or equivalent, consent of instructor.

ME 834 Principles of Structural Stability 3(3,0) 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. *Prreq:* M E 837.

ME 836 Fracture Mechanics 3(3,0) 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. *Prreq:* M E 837.

ME 837 Theory of Elasticity I 3(3,0) 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. *Prreq:* M E 302, MTHSC 208.

ME 838 Theory of Elasticity II 3(3,0) Continuation of M E 837 including topics from either three-dimensional problems associated with an infinite elastic medium, elastic half-space, contact stresses, symmetrically loaded sphere and circular cylinder, or complex variable methods in plane elasticity, stress concentrations problems, singular stresses and fracture, and composite materials. *Prreq:* M E 837, PHYS 812.

ME 843 Advanced Dynamics 3(3,0) Concepts in nonlinear dynamic systems with emphasis to mechanical systems. Classification, stability and bifurcations of equilibrium solutions. Analytical construction, stability and bifurcations of periodic solutions. Floquet theory, Poincare maps. Quasi-periodic solutions, Lyapunov exponents and routes to chaos. Perturbation and asymptotic methods for approximate analytical solutions of weakly nonlinear systems. *Prreq:* M E 846 or undergraduate course in dynamics and differential equations, or consent of instructor.

ME 845 Structural Vibrations 3(3,0) Vibrations of lumped-parameters systems; free and forced vibrations of SDOF and MDOF systems, general eigenvalue problem and modal analysis. Variational approach and energy methods. Vibrations of distributed-parameter systems; strings, bars, shafts, beams, membranes and plates. Approximate methods; Rayleigh's Quotient, Rayleigh-Ritz methods, method of functions expansion, Galerkin's and assumed mode methods. *Prreq:* M E 846 or an undergraduate course in vibration or dynamics and differential equations, or consent of instructor.

ME 846 Intermediate Dynamics 3(3,0) Kinematics and dynamics of particles, rigid and elastic bodies using vectorial and analytical approaches. Fundamentals of analytical dynamics, holonomic versus nonholonomic constraints, virtual displacements and work, Hamilton's Principle and Euler-Lagrange's equations. Rigid-body dynamics; principal axes and Euler angles. Kinematics and dynamics of elastic bodies. *Prreq:* M E 305 or undergraduate course in dynamics and differential equations, or consent of instructor.

ME 852 Advanced Finite Element Analysis 3(3,0) Application of variational and weighted residuals methods; nonlinear analysis, steady-state and time-dependent problems; application of commercial finite element codes; advanced computational procedures. *Prreq:* C E 808 or equivalent or consent of instructor.

ME (E C E) 859 Intelligent Robotic Systems 3(3,0) See E C E 859.

ME 861 Materials Selection in Engineering Design 3(3,0) 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 are presented.

ME 870 Advanced Design Methodologies 3(3,0) Nurturing of creativity; decision-making processes for design; in-depth study of the mechanical design process and tools; quality function deployment, concurrent design, systemic design, robust design, design for assembly and axiomatic design.

ME 871 Engineering Optimization 3(3,0) Optimization in the context of engineering design; nonlinear and linear, static and dynamic, constrained and unconstrained formulation and solution of practical problems; structural optimization; multiobjective optimization; genetic algorithms; simulated annealing.

ME 872 Design Automation for Mechanical Engineers 3(3,0) Students are exposed to data structures, search algorithms, geometric algorithms, geometric modeling, and software engineering for mechanical engineers. Students design and implement mechanical CAD software packages. Emphasizes the use of software development tools, algorithm design, and their interfaces in mechanical engineering. *Prreq:* Programming experience or consent of instructor.

ME 873 Research Methods in Collaborative Design 3(3,0) Topics include research methods for studying collaborative design, influencing factor of collaboration, computer issues in collaboration, and mechanical engineering as facilitated by collaboration. Technical writing and experimentation are emphasized.

ME 891 Master's Thesis Research 1-12

ME 893 Selected Topics in Mechanical Engineering 1-6(1-6,0) Topics not covered in other courses. May be repeated for credit.

ME 930 Advanced Topics in Heat Transfer 1-6(1-6,0) Topics not covered in other courses. May be repeated for a maximum of six credits.

ME 931 Advanced Topics in Fluid Mechanics 3(3,0) Topics not covered in other courses. May be repeated for a maximum of six credits.

ME 932 Advanced Topics in Thermodynamics 3(3,0) Topics not covered in other courses. May be repeated for a maximum of six credits.

ME 991 Doctoral Dissertation Research 1-12

MICROBIOLOGY

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

MICRO 601 Microbial Diversity and Ecology 3(3,0) In-depth survey of microbial morphology, ecology and diversity. Study of the interaction and adaptation of microbes in a wide range of environmental conditions, including consideration of their metabolism, nutrition, growth and the use of microbiological assays. *Prreq:* CH 201 or 223, 227, MICRO 305.

MICRO 602 Environmental Microbiology 3(3,0) Discussion of microorganisms in air, terrestrial and aquatic environments and how they are used for environmental restoration activities. Topics include the nature of biofilms, interactions of microbes with inorganic and organic constituents, processes to implement bioremediation in surface/subsurface environments, and treatment of solid, liquid and gaseous waster streams. *Prreq:* MICRO 305, 401, one semester of organic chemistry, or consent of instructor.

MICRO 603 Marine Microbiology 3(2,3) Discussion of the microbes that inhabit the marine environment, their peculiar physiological traits and contributions to the ecology of oceans. *Prreq:* MICRO 305, organic chemistry.

MICRO 607 Food and Dairy Microbiology 4(3,3)

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. *Prreq:* BIOCH 305 or CH 201 or 223, MICRO 305.

MICRO 610 Soil Microbiology 3(3,0) 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. *Prreq:* MICRO 401 or consent of instructor.

MICRO 611 Pathogenic Bacteriology 3(3,0) Study of pathogenic bacteria and their virulence mechanisms. Emphasizes host-microbe interactions, responses to infection and treatment, and research strategies for various topics of bacterial pathogenesis. *Prreq:* MICRO 305, 414.

MICRO 612 Bacterial Physiology 3(3,0) Considers the cytology, physiology, metabolism and genetics of bacteria including growth and death, reproduction and mutation, nutrition and metabolic pathways, regulatory mechanisms, and effects of environment. *Prreq:* CH 224, MICRO 305, one semester of biochemistry, or consent of instructor.

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

MICRO (AVS, BIOSC) 614 Basic Immunology 3(3,0) Introduction to the immune system of vertebrate animals, with an emphasis on structure, function, regulation, and cellular and molecular mechanisms of immune responses. *Prreq:* BIOSC 461 and MICRO 305.

MICRO 615 Microbial Genetics 3(3,0) Investigates the molecular basis of microbial lives. Topics include essential genes involved in DNA, RNA and protein metabolism; mutations and genome evolution; global gene regulation; and genetic analysis, using both forward and reverse genetics. *Prreq:* BIOCH 301 or 305; GEN 300 or 302; and MICRO 412.

MICRO 616 Introductory Virology 3(3,0) General 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. *Prreq:* BIOCH 301, MICRO 305, or consent of instructor.

MICRO 617 Molecular Mechanisms of Carcinogenesis and Aging 3(3,0)) Discusses alterations that occur at molecular, cellular and tissue levels during cell transformation and aging. Topics include the cell division cycle, signal transduction pathways, oncogenes and tumor suppressors, cell death and cell aging. *Prreq:* BIOCH 301 or 305; MICRO 305; and BIOSC 461; or consent of instructor.

MICRO 619 Selected Topics in Molecular Medicine 3(3,0)

Introduction to various areas of molecular medicine. Examines the latest research and developments in molecular medicine. Designed for students interested in medicine and biomedical research. May be repeated for a maximum of six credits. *Prreq:* BIOCH 301, MICRO 305, or consent of instructor.

MICRO 630 Soil Microbiology Laboratory 1(0,3)

Examination of the microbes residing in the soil and their effects on the soil substratum and resident plant communities. Topics include biogeochemistry, microbial isolation, microcosm development, and characterization of soil microbial communities. *Prreq:* MICRO 410 concurrent enrollment or consent of instructor.

MICRO (BIOSC) 656 Medical and Veterinary Parasitology 3(3,0) See BIOSC 656.

MICRO (BIOSC) 657 Medical and Veterinary Parasitology Laboratory 2(1,2) See BIOSC 657.

MICRO 802 Bacteriological Techniques 4(2,6)

Analytical and experimental procedures used in bacteriology including techniques for studying bacterial cytology, physiology and metabolism; experience in more advanced methods of investigation. Offered fall semester only.

MICRO 803 Special Problems in Microbiology 1-3
Research not related to a thesis.

MICRO 804 Selected Topics in Microbiology 1-3(1-

3,0) 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(2,3) 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. *Prreq:* MICRO (AVS, BIOSC) 614, 615, BIOCH 623 or equivalent, or consent of instructor.

MICRO 806 Pathogenesis and Infectious Disease 3(3,0)

Medically important host-parasite relationships at the cellular and subcellular levels with emphasis on bacterial and viral infections in man. *Prreq:* MICRO 611 or consent of instructor.

MICRO 807 Current Topics in Microbiology 1(1,0)

Students learn and practice skills of literature interpretation, presentation and discussion of articles in relevant and current scientific journals. To be taken Pass/Fail only. May be repeated for a maximum of eight credits.

MICRO (HLTH) 809 Epidemiological Research 3(3,0)

Basic concepts of epidemiology with emphasis on applied aspects rather than theoretical. Examples are drawn from clinical practice. Use of relevant PC-based computer packages is required. *Prreq:* MTHSC 405 or EX ST 801 or consent of instructor.

MICRO 811 Bacterial Cytology and Physiology 4(4,0)

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. Offered spring semester of odd-numbered years only. *Prreq:* BIOCH 423, MTHSC 206, or consent of instructor.

MICRO 812 Bacterial Metabolism 3(3,0)

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. Offered spring semester of even-numbered years only. *Prreq:* BIOCH 423, MTHSC 206, or consent of instructor.

MICRO 815 Advanced Microbial Genetics 3(3,0)

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 lysogenic bacteriophages. Offered fall semester only. *Prreq:* MICRO 415.

MICRO 825 Global Gene Regulation of Bacterial Stress Response 3(3,0)

Focuses on global gene regulation in microbial systems and discusses how microorganisms adapt to various environments. Topics include general stress response, heat shock, envelope stress, oxidative and nitrosative stress, metal homeostasis, sporulation and competence regulation, and bacterial cannibalism. *Prreq:* MICRO 415 or H415 or 615 or consent of instructor.

MICRO 891 Master's Thesis Research 1-12

MICRO 991 Doctoral Dissertation Research 1-12

MIDDLE LEVEL EDUCATION

EDML 811 Middle Grades Language Arts Methods/ Practicum 3(2,4)

Development of instructional practices appropriate for middle grades language arts teachers; familiarization with curriculum materials. Includes field work in local schools. *Prreq:* Admission to MAT program.

EDML 812 Middle Grades Social Studies Methods/ Practicum 3(2,4)

Development of instructional practices appropriate for middle grades social studies teachers; familiarization with curriculum materials. Includes field work in local schools. *Prreq:* Admission to MAT program.

EDML 813 Middle Grades Math Methods/Practicum 3(2,4)

Development of instructional practices appropriate for middle grades mathematics teachers; familiarization with curriculum materials. Includes field work in local schools. *Prreq:* Admission to MAT program.

EDML 814 Middle Grades Science Methods/ Practicum 3(2,4) Development of instructional practices appropriate for middle grades science teachers; familiarization with curriculum materials. Includes field work in local schools. *Preq:* Admission to MAT program.

EDML 821 Middle Grades Language Arts Methods/ Student Teaching 3(2,4) Continued development of instructional practices appropriate for middle grades language arts teachers; familiarization with additional curriculum materials. Includes field work in local schools. *Preq:* Admission to MAT program.

EDML 822 Middle Grades Social Studies Methods/ Student Teaching 3(2,4) Continued development of instructional practices appropriate for middle grades social studies teachers; familiarization with additional curriculum materials. Includes field work in local schools. *Preq:* Admission to MAT program.

EDML 823 Middle Grades Math Methods/Student Teaching 3(2,4) Continued development of instructional practices appropriate for middle grades math teachers; familiarization with additional curriculum materials. Includes field work in local schools. *Preq:* Admission to MAT program.

EDML 824 Middle Grades Science Methods/Student Teaching 3(2,4) Continued development of instructional practices appropriate for middle grades science teachers; familiarization with additional curriculum materials. Includes field work in local schools. *Preq:* Admission to MAT program.

EDML 841 Advanced Middle School Curriculum and Instruction 3(3,0) Concepts and methods for teaching middle school students. Discusses the nature of middle school students, teacher characteristics, curricular and co-curricular programs, organization, and teaching. *Preq:* Acceptance into the MAT Middle Grades program.

MUSIC

MUSIC 600 Elementary Music in the Classroom 3(3,0) Familiarizes teachers in the elementary classroom with traditional Kodaly, Orff and Kindermusik approaches in correlating music with language arts, mathematics and social studies.

MUSIC 680 Audio Engineering II 3(2,2) Advanced course in music technology focused on music production integrating digital audio and virtual instruments *Preq:* MUSIC 380 or consent of instructor.

MUSIC 699 Independent Studies 1-3(1-3,0) Tutorial work for students with special interests in music study outside the scope of existing courses. May be repeated for a maximum of six credits. *Preq:* Consent of department chair.

NURSING

NURS 801 Advanced Family and Community Nursing 3(3,0) Developmental, psychodynamic, social-political and cultural theories and concepts are synthesized and applied to the analysis of health and illness in communities and in families across the life cycle. Roles and functions of advanced practice nurses in promoting community health and family health are examined.

NURS 804 Knowledge Development in Advanced Nursing 2(2,0) Nursing theories and theories relevant to nursing practice and research; processes of theoretical thinking and critical thinking applied to health problems and needs of individuals and their families in the community; theoretical and conceptual models of contemporary practice and research.

NURS 805 Pharmacotherapeutics for Advanced Nursing 3(3,0) Prescription administration and patient/family education in use of pharmacological agents emphasizing drugs prescribed for common or chronic illnesses; drug selection; adverse drug reactions; age-related differences in utilization; regulations affecting nurses' prescriptive authority. *Preq:* NURS 809 or consent of instructor.

NURS 806 Advanced Assessment for Nursing 2(1,3) Comprehensive assessment and diagnosis of health problems and status for individuals of all ages including assessment of families; physical and laboratory/radiologic diagnostic assessments; directed laboratory experiences in advanced assessment of clients of several ages. *Preq:* Undergraduate assessment and NURS 809 or consent of instructor.

NURS 807 Nursing Research Design and Methods 3(3,0) 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. Student must select chairperson prior to enrollment. *Preq:* NURS 804, 808.

NURS 808 Nursing Research Statistical Analysis 2(2,0) Encompasses the use of quantitative research methods in nursing science. Topics include descriptive and inferential methodology, epidemiology and appropriate statistic selection. Computer use is integrated to emphasize applications to nursing. *Preq:* Undergraduate statistics course.

NURS 809 Pathophysiology for Advanced Nursing 3(3,0) Human response to health alterations as they impact nursing knowledge and practice; recognizing the manifestations of health alterations and developing nursing interventions accordingly.

NURS 814 Instructional Technologies for Nursing Educators 3(3,0) Provides novice and experienced nurse educators an opportunity to integrate emerging instructional technologies. Covers theories and trends that support the use of technologies for the enhancement of teaching and learning. Emphasizes the integration of education technologies and the evaluation of current technologies to enhance instruction.

NURS 819 Developing Family Nursing 4(2,6) 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. *Preq:* NURS 801, 804, 805, 806, 809.

NURS 820 Child and Adolescent Nursing 4(2,6) 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 is used to assess, diagnose, intervene and promote continuity of care with clients of these ages irrespective of setting. *Preq:* NURS 801, 804, 805, 806, 809; and 819 (Maternal/ Child CNS students only) or 821 (Family Practitioner students only).

NURS 821 Adult Nursing 4(2,6) 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. *Preq:* NURS 801, 804, 805, 806, 809.

NURS 822 Gerontology Nursing 4(2,6) 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. *Preq:* NURS 801, 804, 805, 806, 809.

NURS 823 Nurse Practitioner Clinical Practicum 6(0,18) 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. *Preq:* FNP track: NURS 819, 820, 821, 822; GNP track: NURS 822, 882, 884; A/GNP track: NURS 821, 822, 882, 884.

NURS 825 Leadership in Health-Care Systems 3(3,0) Examines health-care systems and delivery across the continuum. Emphasizes complexity, influence of internal and external environments, assessment of strengths and opportunities, strategic planning, leadership theories and leading change. Explores implications for middle and executive level health-care leaders. *Preq:* NURS 804 or consent of instructor.

NURS 826 Quality and Outcomes Management in Health Care 4(3,3) Examines the science of systems improvement including the models, methods and tools of process analysis and improvement applied to health care. Emphasis is on designing outcome and evidence-based safe and efficient processes and workflows to achieve customer satisfaction and targeted outcomes. Practicum with quality experts permits guided application of classroom content. *Preq:* NURS 825 or consent of instructor.

NURS 827 Foundations of Nursing Education 3(3,0) Exploration of the foundations of nursing education. Emphasizes curriculum development in nursing for the collegiate or continuing education areas. Current issues and research that influence nursing education. *Preq:* Graduate standing in Nursing.

NURS 828 The Nurse Educator 4(1,9) Roles and functions of nurse educators applied to education of nurses and nursing students in collegiate and continuing education nursing education programs; current issues and research in classroom, laboratory; and continuing education programs. A teaching practicum is required. *Preq:* NURS 827 or consent of instructor.

NURS 829 Theories and Models of Clinical Specialization 3(3,0) 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. *Preq:* NURS 804, CNS graduate option, or consent of instructor.

NURS 830 Clinical Specialty Practicum in Nursing 6(0,18) Advanced practice in a selected clinical specialty area in nursing that emphasizes application of the clinical specialist role. *Preq:* NURS 829 and one of the following: NURS 819, 820, 821, 822, 882, 884, or consent of instructor.

NURS 831 Clinical Research 1-3(1-3,0) Critical thinking and methodologies of scientific inquiry applied to clinical issues/problems encountered in advanced nursing. May be repeated for a maximum of three credits. To be taken Pass/Fail only. *Preq:* NURS 804.

NURS 846 Healthcare Financial Management 3(3,0) Analysis of financial theory and practice for healthcare executives. Includes methods of financial reporting and defines accounting practices for decision making and operating activities. Includes processes for measuring and reporting financial information, analysis, interpretation and use of financial information for planning and controlling the health-care business. *Preq:* Undergraduate accounting.

NURS 847 Internship 4(1,9) Guided practice to apply advanced nursing knowledge in nursing administration in the advanced practice role; joint preceptor and faculty guidance and supervision in the administrative management and care with selected populations in a variety of health care settings. *Preq:* NURS 825, 826, 846, or consent of instructor.

NURS 848 Health Care Policy and Economics 3(3,0) Reciprocal relationship between client, community, health care system, sociocultural and economic variables and policy making; analysis and synthesis of these relationships and their impact on the role and responsibility of the advanced practice nurse and nurse administrator. *Preq:* Graduate standing or consent of instructor.

NURS 850 Information and Control Systems for Nursing Leadership 3(3,0) Computer-based systems of information management and control for nursing environments. Explores data needed for cost-efficient use of nursing resources and effective systems of monitoring, quality assurance, and control; information systems as tools useful to humanistic nursing practice, human resource management and solution of professional and scientific problems. *Preq:* Graduate standing or consent of instructor.

NURS 879 Special Topics in Nursing 1-3(1-3,0-9) In-depth seminar on selected topics such as therapeutic communication, legal and ethical issues in nursing, and health care and political process in health. *Preq:* Consent of instructor.

NURS 882 Primary Care for Elders 4(2,6) Application of the roles and functions of advanced practice in the management of frailty in old age; prevention of early disability and dependence; maintenance of function, independence and self care; cultural, social and ethical issues. *Preq:* NURS 801, 804, 805, 806, 809.

NURS 884 Mental Health and Illness of Adults 4(2,6) Psychosocial, developmental, spiritual and cultural theories are synthesized and applied to the analysis of mental health and illness in adulthood. Considers roles and functions of advanced practice nurses in promoting the mental health of adults and their families. Clinical practice in the community is incorporated. *Preq:* NURS 801, 804, 805, 806, 809.

NURS 889 Special Problems in Nursing 1-6(1-6,0) Problems selected to meet special and individualized interests of students. Up to six hours of NURS 889 may be taken as elective credit. *Preq:* Consent of instructor.

NURS 891 Master's Thesis Research 1-12 Research activities related to thesis; minimum of six hours required. *Preq:* NURS 804.

NUTRITION

NUTR 601 Fundamentals of Nutrition 3(3,0) Biochemical and physiological fundamentals of nutrition applicable to domestic animals and man. Digestive processes and absorption and metabolism of carbohydrates, lipids, proteins, water, minerals and vitamins are considered. Energy metabolism and comparative anatomy and physiology of digestive systems are discussed. Offered fall semester only. *Preq:* BIOCH 305, CH 223, or consent of instructor.

NUTR 624 Medical Nutrition Therapy I 4(3,3) Principles of nutritional assessment, education and counseling skills; development of medical nutrition therapy for individuals with obesity and eating disorders, gastrointestinal disorders, metabolic and renal disorders. *Preq:* BIOSC 223, NUTR 451, or consent of instructor.

NUTR 625 Medical Nutrition Therapy II 4(3,3) Development of medical nutrition therapy for individuals with various disease states including cardiovascular, hepatic, musculoskeletal and neoplastic disorders with consideration of sociocultural and ethnic aspects of food consumption and alternative nutrition therapies. *Preq:* BIOSC 223, NUTR 424, or consent of instructor.

NUTR 626 Community Nutrition 3(3,0) Study of fundamentals of nutrition care delivery in community programs beginning with assessment and problem identification and continuing through the development, implementation and evaluation of nutrition intervention programs. *Preq:* NUTR 451 or equivalent or consent of instructor.

NUTR 651 Human Nutrition 3(3,0) Essentials of nutrition and principal nutritional deficiency conditions. Factors affecting adequacy of dietary intake, methods of determining nutritional status, development of nutrition standards and recent advances in human nutrition. *Preq:* BIOCH 305/306 or equivalent or consent of instructor.

NUTR 655 Nutrition and Metabolism 3(3,0) Concepts of metabolism fundamental to understanding normal and therapeutic nutrition are examined. Bioenergetics as well as metabolism of carbohydrates, lipids, amino acids, vitamins and minerals as they relate to nutrition are discussed. *Preq:* BIOCH 305 or 406 or 423, NUTR 451, or consent of instructor.

NUTR 706 Nutrition for Teachers 3(3,0) Principles of nutrition applied to nutrition education. *Preq:* Consent of instructor.

NUTR 801 Topical Problems in Nutrition 1-3(1-3,0) Topics not covered in other courses or by thesis research. Credit varies with problems selected.

NUTR 802 Special Topics in Nutrition 1-3(1-3,0) Topics of special interest or contemporary subjects not examined in other courses.

NUTR 803 Advanced Human Nutrition 4(4,0) Biochemistry and physiology related to human nutrition and their application to formation and adoption of healthy eating patterns. Emphasis is on individual nutrients in the context of healthy eating patterns throughout the life cycle and on recent advances in human nutrition. *Preq:* BIOCH 305/306, BIOSC 223, NUTR 451, or consent of instructor.

NUTR 804 Nutrition Education of the Public 3(3,0) Analysis of community-based food and nutrition programs to include management, program provision, outcome-based evaluation and integration of services. Emphasis is on outcome-based nutrition education across the lifespan, management and integration of multiple services for targeted population, and public policy development. *Preq:* NUTR 426 or consent of instructor.

NUTR 805 Metabolic Basis of Medical Nutrition Therapy 3(3,0) Integration of metabolism and pathophysiology into medical nutrition therapy recommendations. *Preq:* NUTR 425 or consent of instructor.

NUTR 806 Dietetic Internship 1-6(0,3-18) Internship consisting of preceptor-supervised and faculty-led dietetic experiences in community, clinical and food service settings. Must be taken for six credits during the internship rotations. *Preq:* Acceptance into Dietetic Internship Program.

NUTR 807 Current Issues in Culinary Nutrition Science 3(3,0) Applies the science and practice of healthy cooking to the foods of today and explores the development of future food products. Students participate in research on current issues relevant to the interconnections between food, its preparation, and the consumer.

NUTR 851 Nutrition Seminar I 1(1,0) Current research and developments in nutrition. Topics, selected by the instructor and students, come from student research and nutrition literature. May be repeated for a maximum of two credits, but only if different topics are covered.

NUTR 891 Master's Thesis Research 1-12

NUTR 991 Doctoral Dissertation Research 1-12

PACKAGING SCIENCE

PKGSC 601 Packaging Machinery 3(3,0) Systematic study of types of machinery used to form, fill, seal and handle various packages, products and packaging materials. Emphasizes basic mechanical, electrical, pneumatic and hydraulic components of packaging machinery along with packaging machinery terminology. Discusses methods for machine line optimization and layout. *Preq:* PKGSC 204, PHYS 208, or consent of instructor.

PKGSC 604 Mechanical Properties of Packages and Principles of Protective Packaging 3(3,0) Study of mechanical properties of products and packages and standard methods of determining these properties. Focuses on the functional properties of packages related to shock and vibration isolation and compression. *Prerequisite:* PHYS 207, MTHSC 106, PKGSC 204, or consent of instructor.

PKGSC 616 Application of Polymers in Packaging 4(3,3) Detailed study of polymer science and engineering as applied to packaging science. Includes polymer morphology, rheology, physical properties, processing methods and polymerization. Emphasizes relationships among processing, structure and properties. *Prerequisite:* PKGSC 204, 206; CH 201 or 223; PHYS 207; or consent of instructor.

PKGSC 620 Package Design and Development 3(2,3) Study of principles and methods practiced in designing and developing packages and packaging systems and of methods used to coordinate and analyze package development activities including interfacing with product development, manufacturing, marketing, purchasing and accounting. *Prerequisite:* Second semester Senior standing; PKGSC 320, 368, 401, 404, 416, 430, 440, 464, or consent of instructor.

PKGSC 630 Converting for Flexible Packaging 3(1,6) Study of materials, methods, processes and equipment used in converting web materials for flexible packaging. Laboratory provides hands-on experience preparing and operating pilot-scale converting equipment. *Prerequisite:* PKGSC 204, 206; or consent of instructor.

PKGSC 640 Packaging for Distribution 3(3,0) Packages are exposed to various shipping methods and numerous hazards during distribution. To ensure adequate product protection, packaging professionals need to understand the fundamental principles of distribution packaging design. Topics include ASTM and ISTA packaging test methods, packaging design guidelines for distribution, terminology, transport modes, distribution hazards and protective packaging materials. *Prerequisite:* PKGSC 454 or consent of instructor.

PKGSC 654 Product and Package Evaluation Laboratory 1(0,3) Laboratory experiments to determine properties of packaging materials and to evaluate the response of packages and products to shock, vibration and compression. Students operate standard testing equipment and become familiar with industry-recognized test methods and standards. *Prerequisite:* PKGSC 404 (or concurrent enrollment).

PKGSC 664 Food and Health Care Packaging Systems 4(3,3) Characteristics, engineering properties and applications of various materials and systems used in the packaging of foods, pharmaceuticals and medical devices. Packaging systems for specific food and medical applications are considered. Laboratory and field exercises on food and medical packaging operations and packaging materials are included. Emphasis is on evaluation methods. *Prerequisite:* PKGSC 201, 204, 206, or consent of instructor.

PKGSC 808 Biopolymers in Packaging 3(3,0) In-depth study of the chemical characteristics of biological-based polymers and how these materials can be used in packaging. Students review literature, organize and present material. *Prerequisite:* Consent of instructor.

PKGSC 817 Packaging Materials: Science and Technology 3(3,0) In-depth study of the structure, properties, manufacturing processes and applications of packaging materials. A classical materials science approach is utilized to contrast metals, ceramics, polymers and composites in packaging applications. Course sections include structure, properties and manufacturing of packaging materials. *Prerequisite:* Consent of instructor.

PKGSC 821 Selected Problems 1-4(0,1-12) 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:* Consent of instructor.

PKGSC 822 Selected Topics 1-4(1-4,0) Selected topics in packaging science not covered in detail or contained in other courses. May be repeated for credit. *Prerequisite:* Consent of instructor.

PKGSC 851 Packaging Science Seminar 1(1,0) Current research and related developments in packaging science reviewed by faculty, students and invited lecturers. May be repeated for a maximum of four credits. *Prerequisite:* Consent of instructor.

PKGSC 891 Master's Thesis Research 1-9 Research on a master's thesis topic.

PAN AFRICAN STUDIES

PAS 698 Seminar on Pan African Studies 3(3,0) Research/writing seminar on the African American experience. Selected topics and themes from 1900 to present. *Prerequisite:* HIST 311, 312, 339, or PAS 301.

PARKS, RECREATION AND TOURISM MANAGEMENT

PRTM 621 Recreation Financial Resources Management 3(3,0) Analysis of recreation financial resources management. Deals with revenue sources and their allocation. *Prerequisite:* PRTM 321, Senior standing in Parks, Recreation and Tourism Management, 2.0 cumulative grade-point ratio.

PRTM (GEOG) 630 World Geography of Parks and Equivalent Reserves 3(3,0) Major international patterns in the provision and use of urban and rural parks and recreation are examined. *Prerequisite:* 2.0 cumulative grade-point ratio.

PRTM 631 Methods of Environmental Interpretation 3(2,3) 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 is the major emphasis. Programs are delivered to public audiences in the Clemson area. *Prerequisite:* PRTM 330; Senior standing in Parks, Recreation and Tourism Management; 2.0 cumulative grade-point ratio; consent of instructor.

PRTM 641 Commercial Recreation 3(3,0) Components of offering leisure services and products to the public by individuals, partnerships and corporations for the purpose of making a profit. *Prerequisite:* 2.0 cumulative grade-point ratio.

PRTM 644 Tour Planning and Operations 3(3,0) Provides the opportunity to understand the psychology of touring with emphasis on packaged and group tours and how tours of different types and scale are planned, organized, marketed and operated. *Prerequisite:* PRTM 342, 2.0 cumulative grade-point ratio, consent of instructor.

PRTM 645 Conference/Convention Planning and Management 3(3,0) Provides the opportunity to understand the problems of and solutions to conference and convention planning and management from both the sponsoring organization's and facility manager's perspectives. *Prerequisite:* 2.0 cumulative grade-point ratio.

PRTM 646 Community Tourism Development 3(3,0) Provides a community-based perspective of the organizational, planning, development and operational needs for a successful tourism economy at the local level. *Prerequisite:* PRTM 342, 2.0 cumulative grade-point ratio, consent of instructor.

PRTM 647 Perspectives on International Travel 3(3,0) 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. *Prerequisite:* 2.0 cumulative grade-point ratio.

PRTM 801 Philosophical Foundations of Recreation and Park Administration 3(3,0) Current theories and philosophies in recreation as they are influenced by and have influence on leisure and the changing environment in America. Students develop their own professional philosophies of recreation and leisure.

PRTM 803 Seminar in Recreation and Park Administration 3(3,0) Case problems relating to administration of a park, recreation, or tourism agency.

PRTM 804 Independent Study 1-3(1-3,0) Topics in recreation, leisure and tourism not covered in other courses. Written report of findings is required. May be repeated for a maximum of three credits. *Prerequisite:* Consent of supervising faculty prior to registration.

PRTM 805 Internship 1-3 Field placement in an approved agency under qualified supervision. To be taken Pass/Fail only. *Prerequisite:* PRTM major or consent of instructor.

PRTM 806 Special Problems 1-3(1-3,0) Directed, individual comprehensive investigation of a special problem to use knowledge gained in formal courses, provide experience and training in research and prepare for professional goals. Report of findings is required. May be repeated with a maximum of three credits applied toward graduation requirements. To be taken Pass/Fail only.

PRTM 807 Human Dimension of Outdoor Recreation and Public Land Visitation 3(3,0) Social, psychological and environmental influences on human behavior; identification of theoretical perspectives to explain behavior and to resolve problems in recreation resource management.

PRTM 808 Behavioral Aspects of Parks, Recreation and Tourism Management 3(3,0) Behavioral aspects of recreation, focusing on the social and psychological dimensions of the recreation experience in a variety of environments and activities.

PRTM 811 Research Methods in Parks, Recreation and Tourism Management 3(3,0) Principles, methods and strategies for planning, designing, evaluating and applying studies of recreation. *Preq:* Graduate-level statistics course or consent of instructor.

PRTM 813 Qualitative Research Methods in Parks, Recreation and Tourism Management 3(3,0) Students investigate the theoretical foundations for evolution of use and practical experience with qualitative research methods. The focus is a survey of qualitative research methods and linking these with quantitative methods through reading texts and current peer-reviewed literature. Class activities provide experience with major concepts studied.

PRTM 820 Recreation Resource Policy Issues and Processes 3(3,0) Outdoor recreation policy-formation structures and processes are surveyed through case studies involving past and current public policy issues.

PRTM 821 Grants and Alternative Funding for Parks, Recreation and Tourism 3(3,0) Examines alternative funding options for public and non-profit parks and recreation agencies. Students gain practical experience in grant identification and writing, as well as identifying potential funding sources for agencies.

PRTM 825 Understanding Populations in Parks, Recreation and Tourism Management 3(3,0) Students develop a conceptual understanding of the leisure patterns and constraints of people across the lifespan and of diverse populations. Populations might include ethnic and racial minorities, people with disabilities, people with diverse socioeconomic backgrounds, status, gender, and people with alternate cultures and beliefs.

PRTM 840 Tourism Planning 3(3,0) Tourism planning procedures and techniques; planning process and associated concerns such as market, facility, infrastructure, environment, culture and economics.

PRTM 842 Tourism Discipline 3(3,0) An introduction at the graduate level in how to understand tourism from a global perspective. Introduces students to the contributions that other fields have made to understanding tourism research. The course begins with an examination of how to read academic literature from a critical perspective.

PRTM 843 Tourism Analysis 3(3,0) Selected theories, methods, techniques, practices and principles that govern tourism behavior. *Preq:* Graduate standing or one graduate-level statistics course or consent of instructor.

PRTM (C R P) 844 Outdoor Recreation Resource Management and Planning 3(3,0) See C R P 844.

PRTM 846 Event Management: Special Events 3(3,0) An overview of the meetings, conventions and events industry. Topics include feasibility, viability and sustainability of the event process in addition to event creation and orchestration.

PRTM 847 Event Marketing 3(3,0) Examines a wide range of activities involved with the marketing of special events. Familiarizes students with event production and promotion and the development of marketing plans for public and private events, meetings, fairs, festivals and expositions.

PRTM 848 Risk Management for Events and Meetings 3(3,0) Focuses on the legal, ethical and financial responsibilities of event managers. Topics include risk identification; risk analysis and the planning of events and festivals; health, safety and fire codes; loss prevention; and security controls. Utilizes practices and procedures used by events and festivals.

PRTM 849 Sustainable Event Management 3(3,0) Examines the impacts events have on the environment. Practices related to reduction of social and environmental impacts events have are discussed. Topics include green positioning, carbon reductions, water use and conservation, ethics, and waste management.

PRTM 850 Sustainable Tourism: Myth or Reality? 3(3,0) Provides students with exposure to issues related to developing sustainable tourism, both in developing and developed countries. Emphasis is on understanding global and local politics, policies, environments and social and cultural impacts stemming from developing sustainable tourism.

PRTM 856 Heritage Tourism 3(3,0) Many tourist itineraries contain a heritage component. Whether it's visiting a local museum or witnessing a traditional ceremony, heritage can be one of the focal points of a vacation. This course offers critical readings and discussion about heritage and its role in tourism.

PRTM 881 Therapeutic Recreation Theories and Concepts 3(3,0) Provides students with the opportunity to analyze critically the philosophical positions influencing service delivery and the theories underlying therapeutic recreation practice models and service delivery. *Preq:* PRTM 880 or undergraduate degree in Parks, Recreation and Tourism Management.

PRTM 891 Master's Thesis Research 1-12

PRTM 900 Selected Topics 1-3(1-3,0) In-depth, timely study of trends or problems in parks, recreation and tourism not covered in other courses. May be repeated for a maximum of six credits.

PRTM 908 Advanced Topics 1-3(1-3,0) Topics not covered in other PRTM courses and not directly related to a thesis or dissertation topic. Formal paper is required. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.

PRTM 910 Research Seminar 1(1,0) Current research developments in PRTM and presentation of research projects. May be taken for credit for two semesters. To be taken Pass/Fail only.

PRTM 911 Professional Issues in Parks, Recreation and Tourism Management 1(1,0) Multi-disciplinary perspectives to examine concepts and methods related to professional development of parks, recreation and tourism management graduate students. *Preq:* Admission to PRTM graduate program or consent of instructor.

PRTM 991 Doctoral Dissertation Research 1-12

PHILOSOPHY

PHIL 601 Studies in the History of Philosophy 3(3,0) In-depth study of a selected philosopher, philosophical school, or movement. Topics vary. With departmental consent, may be repeated once for credit. Current topics and course descriptions are available in the department's course offering brochure. *Preq:* Consent of instructor.

PHIL 602 Topics in Philosophy 3(3,0) Thorough examination of a particular philosophical topic, issue, or problem. Topics vary. May be repeated once for credit with departmental consent. Current topics and course descriptions are available in the department's course offering brochure. *Preq:* Consent of instructor.

PHIL 699 Independent Study 1-3(1-3,0) Course of study designed by the student in consultation with a faculty member who agrees to provide guidance, discussion and evaluation of the project. Student must confer with the faculty member prior to registration. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.

PHYSICS

PHYS 617 Introduction to Biophysics 1 3(3,0) Introduction to the application of physics to biological problems. Topics include elementary chemical and biological principles, physics of biological molecules and fundamentals of radiation biophysics. *Preq:* MTHSC 206, PHYS 221, or consent of instructor.

PHYS 620 Atmospheric Physics 3(3,0) Study of physical processes governing atmospheric phenomena. Topics include thermodynamics of dry and moist air, solar and terrestrial radiative processes, convection and cloud physics, precipitation processes, hydrodynamic equations of motion and large-scale motion of the atmosphere, numerical weather prediction, atmospheric electricity. *Preq:* MTHSC 108, PHYS 208 or 221.

PHYS 621 Mechanics I 3(3,0) Statics, motions of particles and rigid bodies, vibratory motion, gravitation, properties of matter, flow of fluids. *Preq:* PHYS 221.

PHYS 622 Mechanics II 3(3,0) Dynamics of particles and rigid bodies, Lagrangian and Hamiltonian formulations, vibrations of strings, wave propagation. *Preq:* PHYS 321 or consent of instructor.

PHYS 632 Optics 3(3,0) Covers a selection of topics, depending on the interest of the student. Topics may include the formation of images by lenses and mirrors, design of optical instruments, electromagnetic wave propagation, interference, diffraction, optical activity, lasers and holography. *Preq:* PHYS 221.

PHYS 641 Electromagnetics I 3(3,0) Study of the foundations of electromagnetic theory. Topics include electric fields, electric potential, dielectrics, electric circuits, solution of electrostatic boundary-value problems, magnetic fields and magnetostatics. *Preq:* MTHSC 208 and PHYS 221, or consent of instructor.

PHYS 642 Electromagnetics II 3(3,0) Continuation of PHYS 441. Study of foundations of electromagnetic theory. Topics include 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. *Preq:* PHYS 441 or consent of instructor.

PHYS 646 Solid State Physics II 3(3,0) Continuation of PHYS 645, including selected topics in solid-state physics such as optical properties, superconductivity, noncrystalline solids, dielectrics, ferroelectrics and nanomaterials. Plasmons, polarons and excitons are discussed. Brief introduction into methods of solid-state synthesis and characterization tools is presented. *Preq:* PHYS 445 or consent of instructor.

PHYS 652 Nuclear and Particle Physics 3(3,0) Study of our present knowledge concerning subatomic matter. Experimental results are stressed. Topics include particle spectra, detection techniques, Regge pole analysis, quark models, proton structure, nuclear structure, scattering and reactions.

PHYS 655 Quantum Physics I 3(3,0) Discussion of solution of the Schroedinger equation for free particles, the hydrogen atom and the harmonic oscillator. *Preq:* PHYS 322 and 441 or consent of instructor.

PHYS 656 Quantum Physics II 3(3,0) Continuation of PHYS 655. Application of principles of quantum mechanics as developed in PHYS 455 to atomic, molecular, solid state and nuclear systems. *Preq:* PHYS 455.

PHYS 665 Thermodynamics and Statistical Mechanics 3(3,0) Study of temperature development of the laws of thermodynamics and their application to thermodynamic systems. Introduction to low temperature physics is given. *Preq:* Six hours of physics beyond PHYS 222 or consent of instructor.

PHYS 811 Methods of Theoretical Physics I 3(3,0) 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(3,0) Continuation of PHYS 811. Use of integral transforms, integral equations, special functions, calculus of variations and numerical approximations in solutions of physical problems.

PHYS (M E) 815 Statistical Thermodynamics I 3(3,0) Fundamental principles of kinetic theory and quantum statistical mechanics; Boltzmann statistics, Fermi-Dirac statistics and Bose-Einstein statistics. *Preq:* A course in thermodynamics or consent of instructor

PHYS 816 Statistical Thermodynamics II 3(3,0) Generalized ensemble theory and fluctuations; applications to solids, liquids, gases and blackbody radiation. *Preq:* PHYS (M E) 815.

PHYS 818 Biophysics I 3(3,0) Application of physical techniques to biological macromolecules and complexes, including discussion of theory and practice of spectroscopic methods, bulk solution and single molecule techniques, x-ray crystallography, small-angle x-ray scattering, cryo-electron microscopy, atomic force microscopy, computational modeling, and molecular dynamics simulations. *Preq:* Consent of instructor.

PHYS 819 Computational Biophysics 3(3,0) Comprehensive coverage of all major areas of Computational Biophysics. Covers beginning basic objects such as DNA, RNA, protein and membrane; reviews the forces and effects acting between atoms and among the molecules; covers modeling protein folding and protein stability; analyzation of molecular association; and practical exercises. *Preq:* PHYS 417 or consent of instructor.

PHYS 821 Classical Mechanics I 3(3,0) 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(3,0) Special relativity in classical mechanics; Hamilton's equations; canonical transformations; Hamilton-Jacobi theory; small oscillations.

PHYS 825 Atmospheric Dynamics 3(3,0) Focuses on middle and upper atmosphere dynamics, including the general circulation, atmospheric tides, gravity waves, planetary waves, instabilities, and wave-meanflow interactions, such as sudden stratospheric warnings, mesospheric circulations, and equatorial dynamics. *Preq:* PHYS 420 or consent of instructor.

PHYS 826 Ionospheric Physics 3(3,0) Focuses on the electrodynamics and plasma physics of the earth's ionosphere, including the unique processes that characterize the auroral zone, mid latitudes, and magnetic equator; and on the interactions between the plasma and neutral components of the ionosphere. *Preq:* PHYS 420 or consent of instructor.

PHYS 841 Electrodynamics I 3(3,0) 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(3,0) 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(3,0) 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(3,0) Continuation of PHYS 845. Electronic properties of solids, band theory of solids, physics of semiconductors, theories of magnetism, and magnetic resonance phenomena.

PHYS 875 Selected Topics 1-3(1-3,0) 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 Training and work on practical problems 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. To be taken Pass/Fail only.

PHYS 891 Master's Thesis Research 1-12

PHYS 951 Quantum Mechanics I 3(3,0) 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(3,0) Continuation of PHYS 951. Time-dependent perturbations, radiation, absorption and emission, relativistic quantum mechanics, introduction to quantum electrodynamics.

PHYS 966 Relativity 3(3,0) Special and general theory of relativity including tensor calculus, Lorentz transformation and three experimental tests of general theory: planetary motion and advance of perihelion of Mercury, bending of light rays in gravitational fields, and gravitational shift of spectral lines.

PHYS 991 Doctoral Dissertation Research 1-12

PLANNING, DESIGN AND THE BUILT ENVIRONMENT

PDBE 801 Advanced Theory in Environmental Design and Planning 3(3,0) Critical assessment of history and theory in the fields of design, planning and construction. Topics include scientific knowledge, interpretive and critical inquiry, theories of urban form and human settlement. *Preq:* Master's-level course in theory related to design, planning and construction.

PDBE 804 Readings in Real Estate 3(3,0) Historical and contemporary readings in real estate designed to provide exposure and depth of coverage for important works in the field. May be repeated for a maximum of six credits. *Preq:* PDBE student.

PDBE 805 Readings in Architecture 3(3,0) Historical and contemporary readings in architecture designed to provide exposure and depth of coverage for important works in the field. May be repeated for a maximum of six credits. *Preq:* EDP 801 and consent of instructor.

PDBE 806 Readings in Landscape Architecture 3(3,0) Historical and contemporary readings in landscape architecture designed to provide exposure and depth of coverage for important works in the field. May be repeated for a maximum of six credits. *Preq:* EDP 801 and consent of instructor.

PDBE 807 Readings in City and Regional Planning 3(3,0) Historical and contemporary readings in city and regional planning designed to provide exposure and depth of coverage for important works in the field. May be repeated for a maximum of six credits. *Preq:* EDP 801 and consent of instructor.

PDBE 808 Readings in Construction Science and Management 3(3,0) Historical and contemporary readings in construction science and management provide exposure and depth of coverage for important works in the field. May be repeated for a maximum of six credits. *Preq:* EDP 801 and consent of instructor.

PDBE 810 Contemporary Issues in Environmental Design and Planning 3(3,0) Interdisciplinary seminar providing an overview of theory and methods related to environmental design and planning. With that background, focus is on important contemporary and emerging issues affecting the built environment. *Preq:* PO ST (C R P) 870 or consent of instructor.

PDBE 812 Seminar in Environmental Design and Planning 1(1,0) Weekly colloquium to provide a forum for faculty, students and invited speakers to address important issues of the day. May be repeated for a maximum of four credits.

PDBE 815 Research Design in Environmental Design and Planning 3(3,0) Philosophy and method of scientific research. Within that context, students prepare a preliminary proposal for their dissertation research. *Prerequisite:* EDP 801, EX ST 801, or equivalent.

PDBE 816 Research Design Practicum 3(3,0) Provides an opportunity to improve and test the ability to employ the craft of research by carrying through a semester-length research project that will be the preliminary research for the student's dissertation project. *Prerequisite:* Consent of instructor.

PDBE 820 Instructional Design Delivery 3(3,0) Presents information on teaching technique including discussions of cognitive learning, motivation, course organization, interactive lecturing and experiential learning.

PDBE 990 Directed Studies 3(3,0) Special topics not covered in other courses. Emphasizes field studies, research activities and current developments in architecture, construction science and management, landscape architecture and planning. May be repeated for a maximum of six credits. *Prerequisite:* Consent of advisor.

PDBE 991 Doctoral Dissertation Research 1-18

PLANT AND ENVIRONMENTAL SCIENCES

PES 825 Seminar 1(1,0) Special topics and original research in plant and environmental sciences. To be taken Pass/Fail only.

PES 826 Scientific Writing 1(1,0) Written communication in the plant sciences. To be taken Pass/Fail only.

PES (CSENV) 850 Agricultural Biotechnology 2(2,0) See CSENV 850.

PES 891 Master's Thesis Research 1-18

PES 991 Doctoral Dissertation Research 1-18

PLANT PATHOLOGY

PL PA (ENT) 606 Diseases and Insects of Turfgrasses 2(2,0) Host-parasite relationships, symptomatology, diagnosis, economics and control of infectious diseases of turfgrasses; and life histories, diagnosis and control of important insect pests of turfgrasses. *Prerequisite:* ENT 301, PL PA 310, or equivalent; or consent of instructor.

PL PA (ENT) 608 Diseases and Insects of Turfgrasses Laboratory 1(0,3) Laboratory to complement PL PA (ENT) 406 to learn symptomatology, diagnosis and control of infectious diseases of turfgrasses and diagnosis of damage caused by important insect pests of turfgrasses. *Prerequisite:* PL PA (ENT) 406.

PL PA 611 Plant Disease Diagnosis I 2(1,2) 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 are taught. Diagnosis of a wide variety of diseases of cultivated and wild plants is carried out. Offered summer session only. *Prerequisite:* PL PA 310 or equivalent.

PL PA (BIOSC) 625 Introductory Mycology 3(3,0) See BIOSC 625.

PL PA (BIOSC) 626 Mycology Practicum 2(1,3) See BIOSC 626.

PL PA (BIOSC) 654 Plant Virology 4(3,3) See BIOSC 654.

PL PA 659 Plant Nematology 3(2,3) Introduction to nematodes emphasizing plant parasitic nematodes. Introduces morphology of nematodes as it relates to their taxonomic position and ability to cause diseases. Includes diagnosis and control of nematode diseases, along with use of nematodes in studies of molecular interaction and genetics involvement in developing resistance. *Prerequisite:* PL PA 310 or consent of instructor.

PL PA 670 Molecular Plant Pathogen Interactions 3(3,0) Study of the interactions of plants and pathogens at the molecular level. Investigates the molecular and genetic components of plant disease and how these can be used for improvement and understanding of how diseases occur and how these can be used for possible disease management. *Prerequisite:* PL PA 310.

PL PA 802 Selected Topics 1-3(1-3,0-6) Current advances in phytopathology and physiology, diseases of specific crops and specialized laboratory protocol. May be repeated for credit. *Prerequisite:* Consent of instructor.

PL PA 805 Special Problems in Plant Pathology 1-12 Research not related to a thesis. *Prerequisite:* PL PA 411 or equivalent and consent of instructor.

PL PA 807 Seminar 1(1,0) Areas of plant pathology and plant physiology not covered by formal courses. Relevant literature is reviewed. Material is organized and presented by students. To be taken Pass/Fail only.

PL PA 809 Analytical Techniques in Plant Science 3(2,3) Theory of and practice in current techniques of separation science; hands-on experience with extraction, isolation and characterization of chemical compounds associated with plants and microorganisms using techniques such as thin layer chromatography, gas chromatography, mass spectroscopy, high pressure liquid chromatography and electrophoresis. *Prerequisite:* Organic chemistry, general biochemistry, or consent of instructor.

PL PA 813 Fungal Ecology and Pathology 3(2,3) Study of the biology and activities of fungi with emphasis on their interactions with other organisms and roles in natural and managed ecosystems. Includes survey of different types of symbiotic relationships with particular attention to plant pathogens and mycorrhizae and their management. *Prerequisite:* BIOSC 425, 426.

POLICY STUDIES

PO ST 810 Political Economy 3(3,0) 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, decision rules consistent with these objectives and constraints and the likely outcomes of various policy objectives. *Prerequisite:* ECON (AP EC) 820 or consent of instructor.

PO ST 822 Policy Analysis and Political Choice 3(3,0) Opportunities and constraints 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 consent of instructor.

PO ST 842 Ethics and Public Policy 3(3,0) Exploration of 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 comparable standards for privately employed policy professionals. *Prerequisite:* Admission to certificate or PhD program in Policy Studies or consent of instructor.

PO ST 843 Organization Theory and Public Management 3(3,0) 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, course draws on business and public administration, social psychology, economics, political science and sociology. *Prerequisite:* Admission to certificate or PhD program in Policy Studies or consent of instructor.

PO ST (C R P) 845 Water Policy and Law 3(3,0) See C R P 845.

PO ST 851 Rural Sustainable Development: Evolution of Public Policy 3(3,0) 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 PhD program in Policy Studies or consent of instructor.

PO ST 861 Space Policy 3(3,0) 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. Examination of origins of programs and evolution of associated policy issues from a national and international perspective. *Prerequisite:* Admission to certificate or PhD program in Policy Studies or consent of instructor.

PO ST (C R P) 870 Seminar in Sustainable Development 3(3,0) Concept of sustainable development traced from its historical roots through the popularization of the term in the international development literature; scientific base and the application of sustainability through economic sectors and building practice. Students conduct individual/group research projects.

PO ST 890 Directed Study in Public Policy 3(3,0) Students pursue readings and research in individual public policy topics under the direction of a Policy Studies faculty member. May be repeated for a maximum of six credits, but only if different topics are covered. *Prerequisite:* Consent of instructor.

PO ST 893 Internship in Policy Analysis 3(3,0)

Twelve-week supervised internship with an approved public or private entity focusing on policy analysis. Monthly reports by student and agency are required. To be taken Pass/Fail only. *Prerequisite:* Two semesters of coursework in Policy Studies program.

PO ST 898 Policy Analysis Workshop 3(0,6)

Provides experience with contemporary policy issues. Students work in small groups with clients compiling information, developing policy options and conducting analysis to address a policy issue. White paper is prepared analyzing policy options and making recommendations to policy makers. Typically taken in fourth semester. *Prerequisite:* Three semesters of coursework in Policy Studies program.

PO ST 899 Selected Topics in Policy Studies 3(3,0)

Intensive investigation of selected current and emerging public policy issues emphasizing current literature and results of current research. May be repeated for a maximum of six credits, but only if different topics are covered. *Prerequisite:* Consent of instructor.

PO ST 904 Policy Analysis Seminar I 2(2,0)

Seminar module focusing on research methodology with readings and discussion. *Prerequisite:* Three semesters of coursework in Policy Studies program.

PO ST 905 Policy Analysis Seminar II 1(1,0)

Seminar involving student research with articles prepared for a professional audience and presented as part of the seminar. *Prerequisite:* PO ST 904, three semesters of coursework in Policy Studies program.

PO ST 991 Doctoral Dissertation Research 1-18**POLITICAL SCIENCE****PO SC 609 Directed Study in American Politics 1-3(1-3,0)**

Supervised reading and/or research in selected areas of American government. May be repeated for a maximum of six credits; however, no more than three hours credit from PO SC 310, 311, 312, 313, 409, 410 may be applied toward a Political Science major or minor or a Global Politics minor. *Prerequisite:* Consent of instructor.

PO SC 616 Interest Groups and Social Movements 3(3,0)

Empirical and normative examination of the origins, roles and influence of interest groups and social movements in the United States and of the relationships among interest groups, social movements and democratic theory. *Prerequisite:* PO SC 101, Junior standing, or consent of instructor.

PO SC 621 Public Policy 3(3,0)

Introduction to the major approaches to public policy making in American government. Topics include theories and models of policy making, the identification of policy problems, agenda setting, the formulation and adoption of policy, implementation, and program evaluation. *Prerequisite:* PO SC 101, Junior standing, or consent of instructor.

PO SC 623 Urban Politics 3(3,0)

Examines the nature and scope of politics in urban communities and offers an analysis of urban governance, especially in the interaction of public authority and private institutions in metropolitan areas. Emphasis is on the structure, processes and problems challenging governments in urban America. *Prerequisite:* PO SC 101, Junior standing, or consent of instructor.

PO SC 624 Federalism and Intergovernmental Relations 3(3,0)

Introduction to historical, theoretical, legal and fiscal aspects of constitutionally divided government. Federal, state and local division of responsibility for public services is emphasized along with the emerging devolution of those responsibilities from the federal government to states and localities. *Prerequisite:* PO SC 101, Junior standing, or consent of instructor.

PO SC 627 Public Management 3(3,0)

Examination of emerging management problems and issues facing federal, state and local government and the application of management principles, practices and techniques of public administration. *Prerequisite:* PO SC 101, Junior standing, or consent of instructor.

PO SC 628 National Security Policy 3(3,0)

National security threats and policy decision making. Issues covered include weapons of mass destruction, terrorism, organized crime, narcotics, arms control, intelligence and homeland security. Students deliberate and assess threat priorities and crisis management. *Prerequisite:* PO SC 102 or 104, Junior standing, or consent of instructor.

PO SC 629 Global Issues 3(3,0)

Analysis, assessment and management of the principal threats facing global security today. Topics include rogue nations, regional superpowers, alliances, organized crime, illegal weapons proliferation and corruption. Emphasis is on the strategies available to the international community for dealing with these threats. *Prerequisite:* PO SC 102 or 104, Junior standing, or consent of instructor.

PO SC 637 American Constitutional Law: Rights and Liberties 3(3,0)

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. *Prerequisite:* Junior standing or consent of instructor.

PO SC 638 American Constitutional Law: Structures of Government 3(3,0)

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. *Prerequisite:* Junior standing or consent of instructor.

PO SC 642 Political Parties and Elections 3(3,0)

Study of the 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 consent of instructor.

PO SC 648 Studies in Political Economy 3(3,0)

Political economy describes the relationship between social and political order and the production, consumption and trading of goods. Course introduces special topics on political economy and familiarizes students with the work of Smith, Ricardo, Marx, Weber and Hayek. *Prerequisite:* Junior standing.

PO SC 654 Southern Politics 3(3,0)

Examination of the unique political environment of the American South, with emphasis on the events and social forces which have shaped politics in the region since World War II. Course material is approached from a variety of perspectives, including history, literature, social themes and political culture. *Prerequisite:* PO SC 101, Junior standing, or consent of instructor.

PO SC 657 Political Terrorism 3(3,0)

Examination and analysis of the international phenomenon of terrorism in terms of origins, operations, philosophy and objectives. *Prerequisite:* PO SC 102 or 104, Junior standing, or consent of instructor.

PO SC 658 Political Leadership 3(3,0)

Comparative examination of political leaders focusing particularly on types, methods and consequences of leadership and on the relationship between leaders and followers. *Prerequisite:* PO SC 101, Junior standing, or consent of instructor.

PO SC 661 American Diplomacy and Politics 3(3,0)

Analyzes the process of making and implementing strategies to protect and promote American national interests. Focuses on the role of government agencies and executive-legislative relations, as well as the participation and influence of interest groups and the media. Includes a five-day seminar in Washington, DC. *Prerequisite:* PO SC 363 or consent of instructor.

PO SC 680 Gender and Politics 3(3,0)

Examination of the role of gender in politics in the United States and in other countries. Particular emphasis on the role of women in electoral politics, the impact of nationalist violence, and development policies on women's lives, and on women's rights as human rights. *Prerequisite:* PO SC 101, 102, or 104, Junior standing, or consent of instructor.

PO SC (LANG) 685 Global Affairs and Governments 3(3,0)

Designed for teachers and education students who wish to learn how to incorporate global affairs more fully into high school curricula. Overview of major topics involving foreign policies and world politics is provided.

PO SC 689 Selected Topics 1-3(1-3,0)

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:* Consent of instructor.

PO SC 841 Public Data Analysis 3(3,0)

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(3,0)

Literature of the American political system, its institutions and processes.

PO SC 877 Public Policy Evaluation Seminar 3(3,0)

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 Political Science 3(3,0)

In-depth, graduate-level study of a selected political science topic.

PSYCHOLOGY**PSYCH 626 Advanced Physiological Psychology 3(3,0)**

Advanced studies in the biological basis of behavior with emphasis on functional neuro-anatomy and endocrinology. Topics may vary. May not be repeated for credit. *Prerequisite:* PSYCH 324 or consent of instructor.

PSYCH 680 Health Psychology 3(3,0) Study of the role of health-related behaviors in the prevention, development and/or exacerbation of health problems. Emphasis is on the biopsychosocial model and its application in the assessment, treatment and prevention of health problems. *Preq:* PSYCH 201 with a C or better and one 300-level psychology course or consent of instructor.

PSYCH 683 Abnormal Psychology 3(3,0) Introduction to the diagnosis and treatment of mental illness. Uses current diagnostic standards for mental disorders as a framework for understanding the symptoms, causes and treatments of the most commonly observed maladaptive behaviors. *Preq:* PSYCH 201 with a C or better and one 300-level psychology course or consent of instructor.

PSYCH 689 Selected Topics 3(3,0) Seminar in current topics in psychology. Topics vary from semester to semester and are announced prior to each semester's registration. May be repeated once for credit, but only if different topics are covered. *Preq:* PSYCH 201 with a C or better and one 300-level psychology course or consent of instructor.

PSYCH 810 Research Design and Quantitative Methods I 3(3,0) Overview of applied data analysis in industrial and other work-related settings. Analysis techniques focus on the General Linear Model approach to ANOVA and regression. *Preq:* Six credits of statistics, research methods or equivalent.

PSYCH 811 Research Design and Quantitative Methods II 3(3,0) Research methodologies; experimental, quasi-experimental and nonexperimental designs emphasizing applied psychological research; scientific method; basic versus applied research; technical writing; grant writing and ethics. *Preq:* PSYCH 810.

PSYCH 813 Research Design and Quantitative Methods III 3(3,0) Advanced course in applications of multivariate data analysis in industrial and other work-related settings. Topics include the major advanced and multivariate data analytic tools needed for research in applied psychology. *Preq:* PSYCH 810 or consent of instructor.

PSYCH 814 Laboratory in Quantitative Methods 1(0,2) Laboratory in data analysis. Emphasis is on determining and conducting appropriate analyses, along with interpreting and presenting results. Analytic procedures covered include regression diagnostics, mediation, moderation, generalized linear models, hierarchical linear models, and factor analysis. *Preq:* PSYCH 810; *Coreq:* PSYCH 813.

PSYCH 815 Advanced Studies in Systems and Theories 3(3,0) Foundations of contemporary psychology, origins of major theories, conceptions of scientific knowledge implicit in them and reasons for accepting or rejecting them. *Preq:* PSYCH 415 or consent of instructor.

PSYCH 822 Human Perception and Performance 3(3,0) 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 833 Advanced Cognitive Psychology 3(3,0) Research and theory concerning perception, memory, reasoning, problem solving, knowledge representation, psychology of language, semantics, attention, concept formation and other high-level mental processes. Applications of these areas are considered.

PSYCH 835 Advanced Human Factors Psychology 3(3,0) Foundation from which to study interactions between human beings and systems in order to maximize safety, performance and user satisfaction. Integration and application of basic research and theory in sensation, perception, cognition and motor control. *Preq:* Consent of instructor.

PSYCH 837 Ergonomics for Applied Psychology 3(3,0) 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 support of action.

PSYCH 840 Usability Analysis and Crew Assessment 3(3,0) Hands-on exposure to human factors methods for evaluating the usability of computer interfaces and assessing team performance in fast-paced tasks. May include cognitive task analysis, heuristic evaluation, usability testing, sequential data analysis, cognitive modeling, workload and situation-awareness measurement, measurement of team knowledge, operating simulators. *Preq:* PSYCH 810 or 835 or consent of instructor.

PSYCH 852 Advanced Studies in Social Psychology 3(3,0) 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. *Preq:* PSYCH 352 or consent of instructor.

PSYCH 860 Psychology of Training and Evaluation 3(3,0) 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. *Preq:* A course in industrial psychology, personnel psychology, or equivalent.

PSYCH 861 Personnel Psychology 3(3,0) 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. *Preq:* PSYCH 810.

PSYCH 862 Organizational Psychology 3(3,0) Investigation of forms of organizational structure and basic theories of organizations. Includes research and theories on human behavior in organizations including motivation, leadership and job satisfaction. Discusses relationships between theories and research on human behavior and organization development and change. *Preq:* A course in industrial/organizational psychology or equivalent.

PSYCH 863 Work Motivation and Satisfaction 3(3,0) 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. *Preq:* A course in industrial/organizational psychology or equivalent.

PSYCH 864 Performance Appraisal 3(3,0) 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. *Preq:* PSYCH 364 or consent of instructor.

PSYCH 867 Legal Issues in Personnel 3(3,0) Discrimination law and its relevance to the practice of industrial/organizational psychology. Compliance with Title 7, the Age Discrimination in Employment Act and the Americans with Disabilities Act. *Preq:* PSYCH 861 and 871 or consent of instructor.

PSYCH 868 Leadership in Organizations 3(3,0) 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. *Preq:* A course in industrial/organizational psychology or equivalent.

PSYCH 869 Advanced Personnel Selection 3(3,0) Advanced seminar covering details of personnel selection techniques used in organizations. Techniques covered may include biodata, cognitive and physical ability tests, personality tests, interviews and assessment centers. *Preq:* PSYCH 861.

PSYCH 871 Psychological Tests and Measurement 3(3,0) 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. *Preq:* Consent of instructor.

PSYCH 873 Structural Equation Modeling in Applied Psychology 3(3,0) Fundamentals of the statistical techniques involved in structural equation modeling (SEM) in applied psychology. SEM is a regression-based technique that incorporates elements of path analysis, confirmatory factor analysis and structural models. *Preq:* PSYCH 810 or consent of instructor.

PSYCH 882 Survey of Occupational Health Psychology 3(3,0) Issues in the newly developing field of occupational health psychology; integration of knowledge bases from human factors, industrial-organizational, health psychology and related disciplines; biopsychosocial perspective where students develop problem-solving skills and interdisciplinary knowledge. *Preq:* Prior psychology coursework or consent of instructor.

PSYCH 885 Organizational Stress 3(3,0) Considers stressors in the workplace that have the capacity to undermine an individual's well-being and performance. Addresses comprehensive models of organizational stress, methodological challenges in studying workplace stress, factors that reduce the negative impact of stress, and organizational interventions to reduce the negative consequences.

PSYCH 891 Master's Thesis Research 1-3

PSYCH 895 Applied Psychology Internship 3-6(0,3) Supervised field experience in industry, business, or government. Site location, on-site supervision and credit hours must be approved in advance by graduate coordinator.

PSYCH 897 Special Problems in Applied Psychology

1-3 Study of a particular topic under the direction of a faculty member. Specific program is organized by student and faculty member and submitted to graduate coordinator for approval. Project is not used to support MS thesis or dissertation. May be repeated for a maximum of 21 credits.

PSYCH 899 Selected Topics 3(3,0)

Selected current and classic topics not covered in other courses. May be repeated for credit.

PSYCH 991 Doctoral Dissertation Research 1-9**PUBLIC ADMINISTRATION**

Courses listed in brackets (e.g., P ADM 702 [POLI 502]) are offered by the University of South Carolina.

P ADM 702 [POLI 502] Research Methods for

Public Administration 3(3,0) 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.

P ADM 821 [POLI 770] Perspectives on Public

Administration 3(3,0) 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.

P ADM 822 [POLI 774] Public Policy Process 3(3,0)

Major models of policy making including incrementalism, rationalism, pluralism and elitism; selected areas of public policy including transportation, poverty, energy and the environment.

P ADM 827 [POLI 773] (FCS) Public Personnel Ad-

ministration 3(3,0) 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.

P ADM 829 [POLI 775] (FCS) Public Financial

Management 3(3,0) Organization and techniques of governmental financial management; budgetary theories; intergovernmental financial relations.

P ADM 830 Constitutional Law for Public Admin-

istration 3(3,0) 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.

P ADM 834 Administrative Law 3(3,0)

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.

P ADM 841 Public Data Analysis 3(3,0)

Considers various aspects of database management, storage and retrieval; data description; univariate, bivariate and multivariate analysis in policy studies and decision-making theory. *Preq:* EX ST 301, MTHSC 301, or equivalent.

P ADM 860 American Government 3(3,0)

Examines literature of the American political system, its institutions and processes.

P ADM 862 (FCS) Administrative Leadership 3(3,0)

Foundations of leadership in public organizations; personal and organizational values underlying decision processes in the public service.

P ADM 863 [POLI 772] Contemporary Adminis-

trative Organizations 3(3,0) Problems, processes and theories of communication, decision-making, agency planning and control in administrative agencies.

P ADM 867 State Government Administration

3(3,0) State government problems and policy issues emphasizing the modernization of government institutions and comparative state politics.

P ADM 868 [POLI 768] Local Government Ad-

ministration 3(3,0) 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.

P ADM 877 Public Policy Evaluation Seminar

3(3,0) Investigates 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.

P ADM 878 (FCS) Selected Topics in Public Ad-

ministration 3(3,0) In-depth study of an applied problem in public administration as seen through the practitioner's eyes; investigates the methods used to address these problems. May be repeated for credit, but only if different topics are covered.

P ADM 879 [POLI 779] Internship in Public Ad-

ministration 1-3(1-3,0) Internship with a government agency requiring a written report detailing the experience.

P ADM 880 [POLI 753] Capstone Seminar in

Public Administration 3(3,0) Term project integrating the material from other courses in the analysis of a contemporary public administration problem. Field work and applied project required.

Preq: Thirty credit hours toward MPA degree and consent of instructor.

P ADM 891 Master's Thesis Research 1-6**REAL ESTATE DEVELOPMENT****RED 800 Real Estate Development Process 3(3,0)**

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. *Preq:* Consent of instructor.

RED 801 Real Estate Market Analysis 3(3,0)

Processes and data sources used to analyze the supply and demand for various building types. Explores demographic, technological and economic trends affecting markets. General market analysis supply and demand approaches, including the use of GIS, are developed and applied primarily to residential, retail and office markets at specific sites. *Preq:* Consent of instructor.

RED 802 Real Estate Development Field Tour Sem-

inar 3(0,9) Examines the processes of creating quality development within the risk-reward framework focusing on design feasibility from the perspectives of the development team. Approximate two-week tour of the South Carolina Coast or other environs visits approximately forty developments and the key actors involved. To be taken Pass/Fail only. *Preq:* MRED student or consent of instructor.

RED 803 Public-Private Partnership Development

3(3,0) Focuses on public-private partnerships in the structuring, negotiating and implementing the design, development, construction and management of buildings and areas. Emphasis is on redevelopment/rehab and infill development; incentive tools and techniques, and market and feasibility issues for development within the risk-reward framework. *Preq:* RED 800 and consent of instructor.

RED 804 Practicum in Residential Development

3(3,0) Exploration of the residential development process. Guest speakers, case studies and field visits are used. Feasibility, market studies and financial analysis for a real world proposed development are completed by diverse student teams. *Preq:* Consent of instructor.

RED 805 Practicum in Commercial Development

3(3,0) Exploration of the commercial development process, especially for office and retail properties. Guest speakers, case studies and field visits are used. Capstone preliminary feasibility analysis is completed by diverse student teams for a real world proposed development. *Preq:* Consent of instructor.

RED 810 Real Estate Seminar Roundtable 1(1,0)

Weekly course that brings students and premier real estate professionals together through on-site or video conference sessions. Presentations and discussions occur regarding cutting-edge projects and industry issues from around the country and internationally. *Preq:* Enrollment in MRED program or consent of instructor.

RED 811 Summer Internship in Real Estate

Development 3(0,9) Preplanned, preapproved, faculty-supervised internship designed to give students on-the-job learning in support of classroom education. Internships must be no less than ten full-time, consecutive weeks with same internship provider. Ancillary study abroad experience or two, three-credit classes in place of internship requirement are possible with approval of MRED Director. To be taken Pass/Fail only.

RED 812 Real Estate Technology 2(2,0)

Demonstrates the technology used by the real estate industry pertaining to site analysis and land planning, vertical design, location analysis and market research and feasibility analysis. *Preq:* Consent of instructor.

RED 813 Real Estate Development Strategic Plan-

ning 3(3,0) Seminar examines the importance of strategy in the success of real estate companies and projects. Leadership, current economic conditions and the real estate cycle are also explored as a way of identifying successful strategies and the role leadership plays in their execution. *Preq:* Second year MRED student.

RED 814 Resort and Second-Home Communities Seminar 3(3,0) Advanced seminar on resort and second-home communities focuses on the full range of development issues pertaining to this important and expanding real estate market. Special emphasis on market and feasibility issues, including analysis of value creation amenities such as golf/tennis, eco-environment, marina, equestrian, skiing and wellness. *Preq:* Second year MRED student.

RED 889 Selected Topics 3(3,0) Topics emphasizing current literature and results of current research. May be repeated for a maximum of nine credits, but only if different topics are covered. *Preq:* Consent of instructor.

RED 890 Directed Study 1-3(0,3-9) Students pursue individual professional interests under guidance of individual faculty as approved by MRED Director. Offered for elective credit for students in MRED program. May be repeated for a maximum of six credits.

RELIGION

REL 601 Studies in Biblical Literature and Religion 3(3,0) Critical examination of a selected topic in biblical studies. Topics vary from year to year. May be repeated once for credit. *Preq:* Consent of instructor.

REL 602 Studies in Religion 3(3,0) Thorough examination of a selected topic in one or more of the religious traditions of the world or of religious life in a particular region. Topics vary from year to year. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.

REL 604 History of Early Christianity 3(3,0) Study of the history, social and doctrinal, of early Christianity up to 600 A.D. *Preq:* Consent of instructor.

REL 699 Independent Study 1-3(1-3,0) Study of selected problems, issues, or movements in religion under the direction of a faculty member chosen by the student. Student and faculty member develop an individualized course of study approved by the department chair prior to registration. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.

RHETORICS, COMMUNICATION AND INFORMATION DESIGN

RCID 801 Histories of Rhetorics 3(3,0) Details historical beginnings from preplatonics, Sophists, Plato, Aristotle to early work of K. Burke (c. 1940). Attention is given to primary-secondary works, including historiographical principles of rhetorics, "the sister arts" (*ut pictura poesis, ephrasis*), and *technē* (as human faculty and mechanical technology). *Preq:* RCID major or consent of instructor.

RCID 802 Cultural Research Methods 3(3,0) Continuation of RCID 801, from 1940 to the present. Focuses on rhetorical inventions as traditional memory and innovative counter-memory. Includes such theorists as K. Burke, G. Ulmer and P. Miller. Includes algorithmic, heuristic, aleatory procedures; classical, modern, postmodern topoi and ethnographies/grammatologies; gestural, oral (aural), literate and electrate logics; graphic/filmic collage-montage; "rhythm science," and sampling remixing. *Preq:* RCID 801.

RCID 803 Empirical Research Methods 3(3,0) Study of assumptions-applications of empirical method in research. Includes sampling techniques, measurement, reliability, validity in collecting-analyzing data, using parametric-nonparametric statistical procedures. Considers approaches to content studies as well as survey and quasi-experimental research. Discusses philosophic writings of scholars such as Popper and Kuhn and content-specific work of Lazarsfeld, Lasswell, Hovland, among others. *Preq:* RCID major or consent of instructor.

RCID 804 Visual Rhetorics 3(3,0) Examines post-1945 modes of visual rhetoric and differing critical perspectives on their functions. Attention is given to key texts and visual creations to gain awareness of how visual codes operate in interior worlds and public life. Topics include the Challenge of Abstraction, Culture of Display, Body as Marketing Tool. *Preq:* RCID major or consent of instructor.

RCID 805 Rhetorics, Communication, Information Technologies 3(3,0) Hands-on examination of communication technologies used widely in academic and industry settings. Focuses on such intermedia as audio, video, Web, MOOs, Blogs, serious computer games and all emerging technologies. *Preq:* RCID major or consent of instructor.

RCID 810 Pedagogy, Administration and Assessment 3(3,0) Theory and praxis of professional communication in academic instruction and selected methods of pedagogical and programmatic assessment. Emphasizes communication-intermedia across the curriculum, academic program administration and scholarship of teaching and learning. May be repeated for a maximum of six credits. *Preq:* RCID major or consent of instructor.

RCID 811 Perspectives in Information Designs 3(3,0) Offers multiple historical and theoretical perspectives for designing and presenting information in visual, oral, print and digital media. Students apply humanistic-rhetorical models to these media and design multimedia projects that demonstrate transactions among theoretical perspectives. May include such models as homeostasis, autopoiesis and virtuality. *Preq:* RCID major, RCID 801, or consent of instructor.

RCID 812 Cultural Critiques of Mechanical Reproductions 3(3,0) Study of critiques and ethics of simulation and sham realities, balanced with counter-critiques/counter-ethics. Considers the "death" of reality and the birth of third order "virtualities." May include such theorists and commentators as Plato, W. Benjamin, M. Heidegger, J. Baudrillard, R. Barthes, P. Virilio, K. Hayles, A. Fausto-Sterling, F. Kittler, G. Deleuze, A. Ronell, M. Taylor. *Preq:* RCID major or consent of instructor.

RCID 813 Special Topics 3(3,0) Study of varying topics determined by such rubrics as history, method, criticism, place, time, subjectivity, models, memory, styles; or determined by such permutations and combinations of rubrics as ethos-gender-sex, theory-practice, rhetoric-poetics, politics-poetics, technē-technology, cultural-digital studies, analog-digital. May be repeated for a maximum of nine credits, but only if different topics are covered. *Preq:* RCID 802, 803, or consent of program director.

RCID 831 Independent Research and Study 3(3,0) Supervised reading in areas and concentrations where there is no comparable seminar or coursework. May be repeated for a maximum of nine credits. *Preq:* RCID 802, 803, 804, 805, five RCID cognate seminars, and consent of program director and chair of advisory committee.

RCID 833 Graduate Readings 3(3,0) Independent research/study focusing on preparation of dissertation project, with two support areas. May be repeated for a maximum of nine credits. *Preq:* RCID 802, 803, 804, 805, five RCID cognate seminars, and consent of program director and chair of advisory committee.

RCID 880 Applied Experience in Research and Communication in Studio 3(3,0) Students apply their seminar work systematically to individual research projects in a primary area and two support areas. Includes an introduction to applied research in a variety of places, both actual and virtual (archives, labs, studios), and to ever-changing notions of intellectual property and creative commons. May be repeated for a maximum of six credits. *Preq:* RCID 802, 803, 804, 805, four RCID cognate (elective) seminars.

RCID 991 Doctoral Dissertation Research 1-18

RURAL SOCIOLOGY

R S (SOC) 601 Human Ecology 3(3,0) 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 on conditions whereby natural resources become public policy concerns. Offered spring semester only. *Preq:* Junior standing or consent of instructor.

R S (SOC) 659 The Community 3(3,0) Close 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 are examined. Structural relations of social class, status and the associations among institutions are explored. *Preq:* Junior standing or consent of instructor.

SECONDARY EDUCATION

EDSEC 637 Technology in Secondary Mathematics 3(3,0) Students learn how to integrate calculators, data collectors and computers in the secondary mathematics curriculum. They solve problems from middle school, Algebra I, Geometry and Algebra II courses. *Preq:* Second semester Junior standing, admission to the professional level.

EDSEC (ENGL) 685 Composition and Language Studies for Teachers 3(3,0) See ENGL 685.

EDSEC 765 Secondary School Curriculum 3(3,1) Principles, techniques and trends in secondary school curriculum development and evaluation.

EDSEC 770 Science Laboratory and Field Instruction 3(3,0) Methods of designing and conducting laboratory and field learning activities in secondary science courses. *Preq:* Undergraduate science teaching methods course or consent of instructor.

EDSEC 803 Advanced Methods of Teaching in the Secondary School 3(3,1) Principles and practices involved in promoting effective active learning in secondary schools.

EDSEC 841 Advanced Studies in the Teaching of Secondary School English 3(3,1) Methods of teaching secondary school English based on research and review of current literature. *Prerequisite:* EDSEC 424 or equivalent, master's degree, or consent of instructor.

EDSEC 842 Advanced Studies in the Teaching of Secondary School Mathematics 3(3,1) Relationship between mathematics teaching theory and practice as shown in the research literature. Emphasis is on inquiry and other student-centered strategies. Issues and techniques in secondary mathematics. *Prerequisite:* EDSEC 426 or equivalent, master's degree, or consent of instructor.

EDSEC 843 Advanced Studies in the Teaching of Secondary School Science 3(3,1) Methods of science teaching theory and practice as shown by current research literature. Emphasis is on laboratory, inquiry and other student-centered teaching strategies. Techniques in science curriculum development. Issues in science teaching. Science teaching leadership skills. *Prerequisite:* EDSEC 427 or equivalent, master's degree, or consent of instructor.

EDSEC 844 Advanced Studies in the Teaching of Secondary School Social Studies 3(3,1) Social studies teaching strategies derived from major theories of learning and contemporary research; curricular issues in social studies education. *Prerequisite:* EDSEC 428 or equivalent, master's degree, or consent of instructor.

EDSEC 846 Current Literature in English Education 3(3,1) Research literature in English education; examination of literature in research methods and curriculum in English teaching. *Prerequisite:* A methods course in English education.

EDSEC 847 Current Literature in Mathematics Teaching 3(3,1) Examination of literature in both the research and curriculum in mathematics education. *Prerequisite:* A graduate teaching methods course or consent of instructor.

EDSEC 848 Current Literature in Science Teaching 3(3,1) 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 consent of instructor.

EDSEC 849 Current Literature in Social Studies Teaching 3(3,1) Examines recent literature in social studies education, in both curriculum and instruction. *Prerequisite:* A graduate teaching methods course or consent of instructor.

EDSEC 861 Teaching Methods and Strategies for Secondary Science 3(3,1) Students develop instructional practices and materials appropriate for secondary science and become familiar with curriculum standards and materials. Includes field experiences in local schools. Emphasis is on inquiry and other student-centered teaching strategies, laboratory management, techniques in science curriculum development, and science teaching leadership skills. *Prerequisite:* Consent of instructor.

EDSEC 862 Teaching Methods and Strategies for Secondary Mathematics 3(3,1) Students develop instructional practices and materials appropriate for secondary mathematics and become familiar with curriculum standards and materials. Includes field experiences in local schools. *Prerequisite:* Consent of instructor.

EDSEC 891 Directed Internship 9(0,27) Application of effective teaching techniques and organization of instructional settings for high school students.

SOCIOLOGY

SOC (R S) 601 Human Ecology 3(3,0) See R S 601.

SOC 604 Sociological Theory 3(3,0) Survey of the development of sociological theory. Required of all sociology majors. *Prerequisite:* SOC 201 and Junior standing or consent of instructor.

SOC 614 Policy and Social Change 3(3,0) Uses the sociological perspective to examine policy development, implementation and evaluation in the public and private sectors. Specifically, focuses on values and ethics and the effects of social change efforts on the outcomes of policy formation, social planning and implementation. *Prerequisite:* SOC 201 and Junior standing or consent of instructor.

SOC 633 Globalization and Social Change 3(3,0) Examination of the social and historical causes of development and underdevelopment in societies. Various sociological theories of development are reviewed. Selected countries are examined in an international context. *Prerequisite:* SOC 201 and Junior standing or consent of instructor.

SOC (R S) 659 The Community 3(3,0) See R S 659.

SOC 660 Race and Ethnicity 3(3,0) Investigation of sociological perspectives on race, ethnic relations and social stratification. Analysis of the impact of social class on minority movements. *Prerequisite:* SOC 201 and Junior standing or consent of instructor.

SOC 671 Population Issues and Methods 3(3,0) 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. Offered fall semester only. *Prerequisite:* ANTH 201 or R S 301 or SOC 201.

SOC 680 Medical Sociology 3(3,0) Sociocultural factors in the etiology and treatment of physical illness; medical occupations and professions; organization of health-care delivery systems. *Prerequisite:* SOC 201 and Junior standing or consent of instructor.

SOC 681 Aging and Death 3(3,0) Sociological orientation to aging populations focusing on the impact of health care, welfare and retirement systems. Includes dying as a social phenomenon, suicide, euthanasia, funerals. *Prerequisite:* SOC 201 and Junior standing or consent of instructor.

SOC 684 Child Abuse and Treatment 3(3,0) Comprehensive examination of child abuse, neglect and exploitation as major social problems; causes, effects and prevalence of physical, sexual and emotional maltreatment; definitional controversies; social policy and legal considerations; therapeutic approaches for children and their caretakers; child maltreatment and the judicial system. *Prerequisite:* SOC 201 and Senior standing or consent of instructor.

SOC 693 Sociology of Corrections 3(3,0) Analysis of correctional alternatives. Topics include sentencing strategies and their impact, prison populations (male, female and juvenile), inmate social structures, treatment and custody issues, community based alternatives (probation, parole, electronic monitoring and work release), and correctional management issues. *Prerequisite:* SOC 390 or consent of instructor.

SOC 694 Sociology of Organized Crimes 3(3,0) Examines the multifarious aspects of criminal organizations, namely their structure, methods and networks. Specific topics may include white-collar crime and traditional, nontraditional and transnational organized crime. *Prerequisite:* SOC 201 or consent of instructor.

SOC 803 Survey Designs for Applied Social Research 4(3,2) Survey research design principles, procedures and techniques used in applied sociology; instrumentation; data collection, management and interpretation. Offered fall semester only. *Prerequisite:* SOC (R S) 303 or equivalent.

SOC 805 Evaluation Research 3(3,0) 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. Offered spring semester only. *Prerequisite:* SOC 803.

SOC 807 Advanced Research Methods 3(3,0) Advanced methods in social research; measuring techniques and data analysis strategies; practical experience in various phases of social research. Offered spring semester only. *Prerequisite:* SOC 803.

SOC 810 Theoretical Models in Applied Social Research 3(3,0) 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 Social Stratification 3(3,0) Stratification is the comprehensive study of social inequalities as manifest in multiple dimensions of economic class, political power, and occupational status, their inter-correlations, and the uneven distributions of these across gender, racial, and ethnic demographics. It crosscuts the major sociological subfields and is relevant for academic, public and policy-centered sociology.

SOC 830 Human Systems Development: Organizations and Society 3(3,0) 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. Offered fall semester only. *Prerequisite:* SOC 430 or equivalent.

SOC 836 Environmental Sociology 3(2,3) 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.

SOC 891 Master's Thesis Research 1-12

SOC 892 Selected Topics in Sociology 3(3,0) Current topics in applied sociology not covered in other graduate courses. May be repeated once for credit.

SOC 895 Field Experience 1-6(0,1-6) Supervised work experience in a public agency or private enterprise to gain planning, research and policy experience. May be repeated once for a maximum of six credits. *Prreq:* 12 hours of 800-level coursework in Sociology.

SOC 896 Independent Study 1-3(1-3,0) Individual readings or research in a topic area selected according to a student's interests or program needs. May be repeated for a maximum of six credits. *Prreq:* Approval of director of graduate studies.

SOC 897 Departmental Research and Professional Development Seminar 1(1,0) Presentation of current research by Department of Sociology faculty, staff, graduate students and visiting researchers. Professional development seminars related to the research process, internships and employment opportunities. May be repeated for a maximum of four credits. To be taken Pass/Fail only.

SOILS AND SUSTAINABLE CROP SYSTEMS

SSCS 645 Regulatory Issues and Policies 1(1,0) Introduction to regulations of agricultural practices and implementation of novel technologies and products. Emphasizes patenting biotechnology inventions and ethical issues. Includes survey of state and governmental agencies with responsibilities to avoid risk to humans, non-target organisms, and preservation of food safety, agricultural resources and natural ecosystems.

SSCS 650 Agricultural Biosystems and Risk Assessment 1(1,0) In-depth discussion of recent articles on agricultural biotechnology and related issues. Independent and comprehensive literature survey and critical discussions on introduction of modified organisms into biological systems, agricultural adoption and bio-risk assessment. Discussions relate to scientific discovery, application and regulatory issues of agricultural biotechnology.

SSCS 651 Agricultural Biotechnology and Global Society 1(1,0) In-depth discussion of recent articles on agricultural biotechnology and related global issues. Includes independent and comprehensive literature survey and critical discussions on implementation of biotechnology products in the context of world agricultural production systems and economics. Discusses the role of international agencies and social and ethical issues.

SPANISH

SPAN 151 Spanish for Graduate Students 3(3,0) 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. To be taken Pass/Fail only. May be repeated once. *Prreq:* Graduate standing.

SPAN 699 Special Topics 3(3,0) Study of timely or special topics in Spanish. May be repeated for a maximum of six credits, but only if different topics are covered. *Prreq:* Consent of department chair.

SPECIAL EDUCATION

ED SP 669 Characteristics of Individuals with Emotional and Behavioral Disorders 3(3,0) Addresses the characteristics of individuals with emotional and behavioral disorders. Consideration is given to historical and legal aspects, definitions, comprehensive assessment and the impact of school, home, culture and society on individuals with behavior disorders. Research findings in the field of behavior disorders are emphasized. *Prreq:* ED SP 370.

ED SP 674 Procedures for Individuals with Emotional and Behavioral Disorders 3(3,0) Assists students in developing specific strategies for teaching individuals with emotional and behavioral disorders, utilizing preventive measures, expanding skills in behavior analysis and implementing the least restrictive intervention warranted. Includes programmatic considerations, social skill instruction, curriculum selection, IEP development and effective transition. *Prreq:* ED SP 469.

ED SP 678 Practicum in Emotional and Behavioral Disorders 3(2,3) Addresses content knowledge, performance skills and professional values for successful teaching of students with emotional and behavioral disorders. Focuses on teacher-directed instruction and the use of critical instructional factors, the use of recommended practice for students with disabilities, and the measurement and analysis of student performance data. *Prreq:* ED SP 474; completion of student teaching.

ED SP 810 Characteristics of Individuals with Learning Disabilities 3(3,0) Addresses definitions, identification procedures, cognitive abilities, social functioning, academic skills, and functional performance of individuals with learning disabilities. *Prreq:* ED SP 370 or equivalent, or consent of instructor.

ED SP 811 Educational Procedures for Individuals with Learning Disabilities 3(3,0) Provides knowledge of educational evaluation and instructional procedures to improve outcomes for individuals with learning disabilities. *Prreq:* ED SP 670, 810 or equivalent, or consent of instructor.

ED SP 812 Practicum in Learning Disabilities 3(1,6) Practical experience in teaching students with learning disabilities under the supervision of college faculty and local mentor teachers. *Prreq:* ED SP 370, 810, 811, or consent of instructor.

ED SP 816 Characteristics of Individuals with Intellectual Disabilities and Autism 3(3,0) An in-depth study of the etiology, assessment procedures, and learning and behavioral characteristics of individuals with intellectual disabilities and autism across the lifespan. *Prreq:* ED SP 370 or equivalent, or consent of instructor.

ED SP 817 Educational Procedures for Individuals with Intellectual Disabilities and Autism 3(3,0) Identification, selection, and preparation of functional curriculum materials and pedagogy for teaching students with intellectual disabilities and autism. A multidisciplinary, student-centered approach to program planning provides the framework. *Prreq:* ED SP 672, 816, or equivalent, or consent of instructor.

ED SP 818 Practicum in Intellectual Disabilities and Autism 3(1,6) Addresses content knowledge, performance skills, and professional values for successful teaching of students with intellectual disabilities and autism. Focuses on teacher-directed instruction and the use of critical instructional factors, the use of recommended practices for students with disabilities, and the measurement and analysis of student performance data. *Prreq:* ED SP 673, 817 or equivalent, or consent of instructor.

ED SP 820 Language Arts Instruction for Individuals with Disabilities 3(3,1) Research-based methods for instructing individuals with disabilities. Includes principles of effective language arts instruction in reading, writing, speaking and listening skills. *Prreq:* A course in reading methods or consent of instructor.

ED SP 821 Educational Assessment of Individuals with Disabilities 3(3,1) 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. *Prreq:* ED SP 370 or consent of instructor.

ED SP 822 Teaching Mathematics to Individuals with Disabilities 3(3,1) 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. *Prreq:* ED SP 370 or consent of instructor.

ED SP 823 Teaching Individuals with Disabilities in Integrated Settings 3(3,1) Strategies for teaching individuals with disabilities in integrated settings; appropriate instruction, accommodations, natural supports, collaboration and consultation. *Prreq:* ED SP 370 or consent of instructor.

ED SP 838 Selected Topics in Special Education 1-3(1-3,0) Specific master's-level special education topics not found in other courses are selected for in-depth study. May be repeated for a maximum of 24 credits, but only if different topics are covered.

ED SP 839 Independent Study in Special Education 1-3(1-3,0) Master's-level study of selected topics in special education under the direction of a faculty member. May be repeated for a maximum of 24 credits, but only if different topics are covered.

ED SP 840 Transition Education and Services for Individuals with Disabilities 3(3,1) Postsecondary options for individuals with disabilities; educational programs and services which support their transition from school to life. *Prreq:* ED SP 370 or consent of instructor.

ED SP 841 Instructional Strategies for Individuals with Disabilities in Secondary School Settings 3(3,1) Instructional procedures for teaching individuals with disabilities in middle and high schools. Research-validated practices in learning strategies, content-area instruction, functional skills and community-based instruction. *Prreq:* ED SP 370 or consent of instructor.

ED SP 853 Legal and Policy Issues in Special Education 3(3,1) The impact of legislation-IDEA, Section 504 and litigation on special education; 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. *Preq:* ED SP 370 or consent of instructor.

ED SP 854 Applied Behavior Analysis 3(3,1) Class members 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. *Preq:* ED SP 370.

ED SP 860 Social Development and Guidance of Young Children in Inclusive Settings 3(3,0) Focuses on the social development and guidance of very young children—infants, toddlers and preschoolers—in inclusive early childhood settings. Explores best practices for teachers of infants, toddlers, preschool and primary age children in diverse education and care settings.

ED SP 930 Critical Issues and Trends in Special Education 3(3,0) Helps students develop an understanding of the role of convergent research evidence in addressing critical issues in special education practices and policies. Focuses on foundational issues of special education, intervention issues and personnel preparation issues.

ED SP 931 Advanced Research in Learning Disabilities 3(3,1) Investigates history, theory, research and practice pertaining to selected issues in methods and curriculum within the field of learning disabilities. Employs research-based interventions in the preparation, selection and adaptation of instruction for students with learning disabilities. *Preq:* ED F 778 and ED SP 821 or consent of instructor.

ED SP 932 Advanced Research in Emotional/Behavioral Disorders 3(3,1) History, theory, research and practice pertaining to selected issues in the fields of emotional/behavioral disorders. Influence of various theoretical approaches in the field. Research-based interventions and curriculum development. *Preq:* ED SP 821.

ED SP 933 Advanced Research in Mental Retardation 3(3,0) History, theory, research and practice pertaining to selected issues in the field of mental retardation; historical treatment; theoretical approaches; research-based interventions; community-based and lifespan curriculum development for individuals with mental retardation. *Preq:* Graduate standing, ED SP 821.

ED SP 934 Evidence-Based Research in Instructional Design and Delivery 3(3,0) Emphasizes the research foundations of special education and the importance of evidence-based instructional design and delivery frameworks that impact important outcomes for students with disabilities.

ED SP 935 Preparing Highly Qualified Special Educators: Research in Teacher Education 3(3,0) Prepares doctoral students for the role of teacher educator. Topics include current issues in teacher education and special education including effective teaching practices in general and special education. Current findings in teacher education and special education research and development and conduct of research are emphasized. *Preq:* Curriculum and Instruction major or consent of instructor.

ED SP 936 Single-Subject Research Design 3(3,0) Provides doctoral students with practical information regarding the conduct, theory and practice of single-subject research methods. Emphasizes skills in design, implementation and analysis of single-subject research. *Preq:* Curriculum and Instruction major or consent of instructor.

ED SP 937 Research in High Incidence Disabilities 3(3,0) Emphasizes research related to characteristics and identification of individuals with high incidence disabilities, as well as evidence-based instructional and behavioral interventions. *Preq:* Curriculum and Instruction major or consent of instructor.

ED SP 953 Legal Trends in Special Education 3(3,0) A critical examination of legislative mandates in special education. Areas of study include the Individuals with Disabilities Education Act, Section 504, the Americans with Disabilities Act, and the Elementary and Secondary Education Act. Pertinent landmark and current litigation are also examined.

ED SP (ED, ED F) 980 Internship in Curriculum and Instruction 1-6(0,3-18) See ED 980.

ED SP (ED, ED F) 991 Doctoral Dissertation Research 1-18 See ED 991.

ED SP (ED, ED F) 994 Directed Research 1-4(1-4,0) See ED 994.

SYSTEMS ENGINEERING

SYS E 801 Systems Engineering I 3(3,0) Educates students on the complete system design process using a project-oriented format. Course consists of topical areas in needs analysis, concept generation and development, prototyping, evaluation, cost analysis, implementation and delivery. *Preq:* Consent of instructor.

SYS E 802 Systems Engineering II 3(3,0) Addresses analysis and design of complex systems by considering human, hardware and software components of the system. Techniques for unambiguously defining a problem and designing a solution are applied to a model problem. Architectural techniques are used to assemble a solution that satisfies functional and non-functional requirements. A range of qualitative and quantitative verification and validation techniques for evaluating the fitness of a solution are examined and used. *Preq:* SYS E 801

SYS E 853 Improving Systems Using Quality and Lean Principles 3(3,0) Students are educated in the theory of quality control, its principles and the application of quality and lean techniques to manufacturing and service systems.

SYS E 859 Capstone Project 3(3,0) Students engage in a capstone experience in the analysis and design of systems by carrying out a substantial project. *Preq:* Admission to the Systems Engineering program.

THEATRE

THEA (ENGL) 630 Dramatic Literature II 3(3,0) See ENGL 630.

THEA (ENGL) 647 Playwriting Workshop 3(0,3) Workshop in the creative writing of plays. May be repeated once. *Preq:* THEA (ENGL) 347 or consent of instructor.

THEA 672 Improvisation: Interpreting and Developing Texts 3(3,0) Practical applications using drama as a learning tool to strengthen writing skills, motivate collaboration and heighten analytical skills. Students 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. *Preq:* Senior standing or consent of instructor.

THEA 687 Stage Lighting I 3(2,1) Theory and practice of stage lighting through an understanding of various lighting instruments, lighting control systems and execution of lighting designs.

THEA 697 Scene Painting 3(2,1) Practical study of basic painting techniques for the theatre including layout, proper use of materials, painting styles and texturing techniques.

THEA 699 Independent Studies 1-3(1-3,0) Tutorial work for students with special interests outside the scope of existing courses. May be repeated for a maximum of six credits. *Preq:* Consent of department chair.

VOCATIONAL/TECHNICAL EDUCATION

VT ED 810 Foundations of Vocational and Technical Education 3(3,0) Evolution of vocational and technical education during the 20th century and current trends; sociological, psychological and philosophical theories underlying current objectives; definition of broad parameters of the field.

VT ED 833 Curriculum Construction in Vocational and Technical Education 3(3,0) Students develop a specific course in a selected vocational and technical education area by specifying performance goals and building around these objectives. *Preq:* AG ED 640 or CTE 670 or equivalent.

VT ED 850 Programs, Concepts and Issues in Vocational and Technical Education 3(3,0) Current activities and debates in vocational and technical education; traditional and innovative programs, career education, school finance, disadvantaged students, handicapped youth, sex equality and other specialized programs.

VT ED 882 Seminar 1(1,0) Current issues and problems and proposed research projects.

VT ED 893 Advanced Research Design and Analysis 3(3,0) 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. *Preq:* AG ED (CTE, ED) 889 or equivalent.

VT ED (ED L) 955 The Two-Year College 3(3,0) See ED L 955.

VT ED 980 Internship in Vocational/Technical Education 1-6 (0,3-18) Internship in which students gain 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. To be taken Pass/Fail only. *Preq:* Consent of major advisor.

VT ED 991 Doctoral Dissertation Research 1-12

WILDLIFE AND FISHERIES BIOLOGY

WFB 610 Wildlife Management Techniques 3(1,6)

Covers field and laboratory methods commonly used in wildlife management and research. Students interact with wildlife professionals. Topics include research methodology, estimating wildlife population characteristics, condition measures and food habits; species determinations, sex and age, capture; population monitoring methods, GIS and mapping techniques, habitat evaluation and improvement. *Preq:* W FB 300 and 350.

WFB 612 Wildlife Management 3(2,3) Basic principles and general practices of wildlife management and conservation are covered. Major problems concerning the management of wildlife resources, with emphasis on upland game species. Laboratory work includes practical work on the Clemson University woodlands and field trips to areas where wildlife management is being practiced. *Preq:* W FB 300 and 350.

WFB 614 Wildlife Nutritional Ecology 3(3,0) Concepts of how terrestrial wildlife obtains and utilizes energy and nutrients in wild ecosystems are taught. Energy and nutrient availability are discussed in the ecological context of distribution, flow and cycling in natural and modified foraging areas. Physiology of digestion for major homeotherms. Offered spring semester only. *Preq:* W FB 300 and 350.

WFB 615 Quality Deer Management 3(3,0) Quality Deer Management (QDM) is a stewardship philosophy that provides desirable hunting experiences by producing white-tailed deer herds with a natural age and sex structure and population size appropriate for habitat conditions. The course emphasizes herd management, habitat management, hunter management and herd monitoring. Online course. *Preq:* Junior standing or consent of instructor.

WFB 616 Fishery Biology 3(2,3) Principles underlying freshwater fish production, major groups of freshwater fishes and their habitats. Topics include identification, age and growth, fecundity, food habits, populations estimation, environmental evaluation, management practices and fish culture. *Preq:* W FB 300 and 350.

WFB 630 Wildlife Conservation Policy 3(3,0) Deals with the ecological rationale and management implications of public policy designed for the conservation of American wildlife resources. Emphasis is on managed-land issues. *Preq:* W FB 300 and 350.

WFB 644 Wildlife Damage Management 3(2,3) Covers the philosophical, sociological, ecological and economic basis for controlling damage caused by animals problem wildlife populations. Emphasis is on fundamentals of prevention and control of damage caused by vertebrate species, especially mammals and birds. Includes interaction with federal and state agencies and private consultants. *Preq:* W FB 300 and 350.

WFB 650 Aquaculture 3(3,0) 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. *Preq:* W FB 300 and 350.

WFB 660 Warmwater Fish Diseases 2(2,0) Study of diseases in warmwater fish including infectious and noninfectious processes. *Preq:* W FB 300 and 350.

WFB 662 Wetland Wildlife Biology 3(3,0) Study of wetland wildlife habitats, emphasizing classification by physical, chemical and biological characteristics; importance of wetland habitat for management and production of wetland wildlife species. Offered fall semester only. *Preq:* W FB 300 and 350.

WFB (BIOSC) 668 Herpetology 4(3,3) See BIOSC 668.

WFB (BIOSC, ENT) 669 Aquatic Insects 3(1,6) See ENT 669.

WFB 676 Field Methods in Avian Monitoring and Conservation 3(1,4) A field-intensive introduction to the identification, ecology and conservation of North American birds and their habitats with an emphasis on southeastern species. Includes avian survey and census techniques. Two or three weekend (Friday-Sunday) field trips are required. *Preq:* BIOL 104/106, 111 or consent of instructor.

WFB 712 Wildlife Conservation for Teachers 2-3(2-3,0) Principles and practices of wildlife conservation providing an overview of wildlife diversity, ecology and management in the state; population census, wildlife identification, capture and habitat management of game and nongame species. For in-service teachers only. *Preq:* Consent of instructor.

WFB 810 Publishing in Natural Resource Journals 2(2,0) 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. Offered spring semester of odd-numbered years only.

WFB 815 Principles of Wildlife Biology 3(2,3) Theories and principles applicable to wildlife biology emphasizing upland game species. Offered fall semester of even-numbered years only.

WFB 818 Waterfowl Ecology and Management 3(2,3) Identification, ecology and management of waterfowl. Laboratory work includes demonstration and application of relevant waterfowl management techniques, current literature topics and field trips. Offered fall semester of odd-numbered years only. *Preq:* BIOSC 441 or W FB 412 or consent of instructor.

WFB 840 Fish Management 3(2,3) 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. Offered fall semester of odd-numbered years only. *Preq:* W FB 416 or consent of instructor.

WFB 860 Diagnostic Procedures of Warmwater Fish Diseases 2(1,2) Warmwater fish disease diagnostic procedures employing proper protocol to be followed by a fish disease diagnostician. Offered summer session of odd-numbered years only. *Coreq:* W FB 460 or consent of instructor.

WFB 861 Selected Topics 1-4(0-4,0-12) Current areas of aquaculture, fisheries and wildlife management and research. May be repeated for credit. *Preq:* Consent of instructor.

WFB 863 Special Problems in Wildlife and Fisheries Biology 1-3(0,3-9) Research not related to a thesis. Credit varies with problems selected. *Preq:* Consent of instructor.

WFB 891 Master's Thesis Research 1-12

WFB 991 Doctoral Dissertation Research 1-18

WOMEN'S STUDIES

WS (ANTH) 623 Women in the Developing World 3(3,0) See ANTH 623.

WS 659 Selected Topics in Women's Studies 1-3(1-3,0) Topics change from semester to semester and are announced prior to registration. May be repeated for a maximum of six credits, but only if different topics are covered.