COLLEGE OF ENGINEERING AND SCIENCE


Courses are offered in astronomy, engineering graphics, and environmental science and policy to provide electives for students in other areas.

Degrees offered are the Master of Engineering, Master of Science and Doctor of Philosophy. 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 the College of Engineering and Science.

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 business, 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 degree 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 EEES 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 graduate 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.

Students for doctoral 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 the 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 advisor and 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:

1. 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.

2. 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.

3. Up to six semester hours from any 600- or 800-level engineering courses may be used to satisfy the requirements of the BS degree. These courses may be counted as technical requirements or electives.

4. 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.

5. 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/eee.

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:

1. 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.

2. 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.

3. 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.

4. 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.

5. 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 BS degree. Once 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/or undergraduate program advisor. Students pursuing Seminars in 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 anytime after 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, 04 will come from foundation courses, 15 from core courses, three from aesthetic electives, and six 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, 805, 808, 819, 863, E C 847, G C 801, MUSIC 680, PSYCH 823, THEA 672, 697.

Studies—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 telecampus 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/ee.

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 (SESE) 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 disciplinary-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 SESE 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

ENVIRONMENTAL ENGINEERING AND SCIENCE

Master of Engineering

Master of Science
Doctor of Philosophy
Environmental engineering and science is concerned with the characterization and control of environmental pollution. Emphasis is placed on applying the fundamental principles of basic and engineering science through research and design to the solution of environmental problems in natural and engineered systems.

The MEng program builds on an ABET-accredited engineering baccalaureate background, while the MS program builds on a student’s previous engineering or science background. Students with a baccalaureate degree in any branch of engineering, as well as chemistry, biology, or related majors with a strong mathematical background may be admitted to the program.

Students may specialize in one of six areas: environmental health physics; environmental process engineering; nuclear environmental engineering and science; sustainable systems and environmental assessment; subsurface and surface processes; or environmental chemistry. Research master’s degree candidates must complete 24 hours of coursework and six hours of research culminating in the presentation of a satisfactory thesis for MS candidates or a special problem report for MEng candidates. The MS nonthesis option, which requires 30 hours of coursework and three hours of independent study, is available. The coursework for all master’s students must include E&S 802, 843, and 851. A final examination is required of all master’s candidates.

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 Environmental Engineering and Science
Combined BS in Environmental Engineering/MS, MEng 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/ese/.

Combined BS in Chemical Engineering/MS, MEng 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. A third semester is recommended.
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, CPSC 888 Directed Projects in Computing. Students also take 18 hours of dissertation research (CPSC 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) 805 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 specialization. Courses 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 computer science. Students admitted without this background will be required to complete successfully all 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 GS6 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 I E 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 metalurgy, 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

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 advised 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 Engineering 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 augment 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 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, (ME) 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.