

## ENGINEERING

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The College of Engineering offers graduate programs leading to the Master of Science degree in civil engineering, electrical engineering, mechanical engineering, mining engineering and manufacturing systems and a Doctor of Philosophy degree in engineering science. To support these graduate programs, the college has well equipped laboratories and computer facilities that are housed in a modern engineering complex. Additional research opportunities and funding are provided through the Center for Advanced Friction Studies, Coal Research Center, the Materials Technology Center, and the Office of Research Development and Administration.

### Doctor of Philosophy in Engineering Science

Faculty in the departments of Civil Engineering, Electrical and Computer Engineering, Mechanical Engineering and Energy Processes, and Mining and Mineral Resources Engineering participate in this program.

The Doctor of Philosophy degree in engineering science is available for three concentrations in four engineering departments. The areas of concentration are as follows:

#### Areas of Concentration

*Mechanics* (solids, fluids, geotechnical, mechanical systems, and materials). This area provides students with in-depth knowledge in solid mechanics, fluid mechanics and water resources, structures, experimental stress analysis, soil and rock mechanics, mine ground control, materials science and materials engineering.

Research thrusts include nonlinear response, ultimate strength, and instability behavior of structures under static and dynamic loading conditions; soil mechanics and foundation engineering; finite element modeling of fluid and mechanical systems; analysis of surface and ground water flow systems; mechanics of composite materials and rocks; solid/liquid separation mechanics; field geotechnical studies in underground mines and tunnels; ceramics processing; hybrid-nano composite materials; nano-materials; amorphous materials, electro-deposition of metals and alloys and their characterization; porous materials; coal combustion byproduct derived composites; and surface and interface phenomena; mechanical systems: autonomous systems, vibration, and non-destructive evaluations of materials.

*Electrical Systems* (computer engineering, communications and control, signal processing, power systems, electromagnetic and solid-state electronics). A student interested in advanced study in this area of concentration may select from the following areas: digital systems, computer engineering, artificial neural networks, expert systems, pattern recognition, communication systems, wireless communications and networks, signal processing, mechatronics, control systems, robotics, power systems, power electronics, electromagnetics, microwaves, solid state electronics, gaseous electronics, laser electronics, optical computing and biomedical signal processing.

Current research in this area includes advanced voltage control systems; power systems; power electronics; neural networks; automatic speech recognition; multivalued and fuzzy logic; computer architecture; CAD for VLSI and design automation; fault-tolerant computing and design; electronic testing and design for testability; circuit and system theory; communication theory; detection and estimation theory; mobile ad-hoc networks; computer vision; advanced control systems; optical computing; microwaves and antennas; plasma processing; microwave strip antennas; wireless communications; computer networks; superconductivity; magnetic materials and memory devices; transport phenomena in solids.

*Fossil Energy* (mining, coal conversion, combustion, heat transfer, coal utilization, pollution control, energy conversion). A student with interests in fossil fuel extraction and utilization and associated environmental problems or thermal sciences may specialize in this area. Typical course work includes mining, processing, combustion, thermodynamics, heat transfer, energy management, and conversion of fossil fuels, as well as environmental problems' abatement associated with fossil fuels.

Current areas of research include advanced coal cleaning; recovery of coal from waste materials; surface-mined land reclamation; systems simulation of coal mining; coal conversion; advanced combustion systems; coal combustion byproduct management and utilization; soil and surface water hydrocarbon decontamination; energy conversion: HVAC, internal and external combustion engines and fuels, heat transfer and energy conservation.

#### Admission and Retention

*Regular Admission.* Admission to the doctoral program requires a master's degree in engineering or its equivalent. Applicants for the doctoral degree must meet Graduate School admission requirements and be approved by the college graduate studies committee. A non-refundable application fee of \$20.00 must be submitted with the application. Attach your check or money order, payable to Southern Illinois University, to the top of the application form. Do not send cash. Only checks or money orders payable to United States banks will be accepted. In addition to Graduate School and other college requirements, the committee ordinarily requires a grade point average of 3.5 (4 point scale) in graduate level work. Applicants are required to submit GRE scores in support of their application for admission. Except for persons from English-speaking countries, international students are required to have a TOEFL score of 550 (paper score) or 213 (computer score) or higher for admission.

Upon admission to the doctoral program, an interim graduate adviser will be assigned for each student by the college associate dean for academic affairs. This adviser will be responsible with the student for planning the student's course work. The college graduate studies committee will be kept informed of the student's program of study.

Retention is governed by the rules of the Graduate School. Students should avoid the accumulation of incomplete grades. No student with more than two incomplete grades can be awarded a graduate assistant appointment, and a student holding a graduate assistant appointment is subject to having the appointment terminated upon acquiring two or more incomplete grades.

*Accelerated Entry.* After at least two semesters in residence in an engineering M.S. program and after completing 18 hours of approved coursework, a student may petition for accelerated entry into the Ph.D. program. Such entry is permitted only in special circumstances to superior students who have exhibited evidence that he/she is prepared to begin the research activities of doctoral-level study. In addition, the student must have an undergraduate grade point average of 3.5 or higher, have GRE scores that are at or above the 45th percentile for the verbal component, 80th percentile of the quantitative component and 80th percentile for the analytical component or a combined total percentile score of 225 or higher and have a TOEFL score of at least 600 (paper score), 250 (computer score). In addition, the student must pass a college-administered qualifying examination.

*Physics.* Based on a memorandum of understanding signed between the College of Engineering and the College of Science, Physics Department can participate in the Engineering Science Ph.D. Program. The College of Engineering Ph. D. Committee reviews the applications and approves admissions. One of the participating Physics faculty serves on the Committee. An M.S. in Physics will be considered as a degree equivalent to an M.S. in Engineering for admission purposes. The student's Ph.D. committee will determine any makeup work that may be required.

### Curriculum

A minimum of 26 semester hours of course work, including 2 hours of seminar, and 24 semester hours of dissertation research is required. The course work must be completed in 2 areas: area of concentration and program core. A student must complete a minimum of 15 hours of course work relevant to an area of concentration. The course work in the area of concentration is intended to provide depth in the student's area of research. The program core consists of 11 hours of course work. A dissertation must be completed in the student's area of research interest with the approval of the dissertation committee.

### Program Core

The program core consists of 11 hours of course work: 6 hours in math, 3 hours in engineering or science and 2 hours of seminar. The math courses to choose from are: all 400 and 500, except MATH 400, 411, 412, 458, 480, 483, 511, 512, 513, and 516. The engineering courses to choose from are: ENGR 530—Engineering Data Acquisition: Theory and Practice, ENGR 540— Design of Engineering Experiments, ENGR 545—Advanced Numerical Methods in Engineering, ENGR 521—Probability and Stochastic Processes for Engineers. The science course could be any 400 or 500 level course in Computer Science, Physics, Chemistry or Geology, as approved by the student's advisor. The seminar course, ENGR 580, must be taken in two separate semesters, each time as one-hour course.

### Guide for Core and Concentration Courses

- Only two 400-level courses (typically 6 hours) can be counted towards the minimum required 26 semester hours of course work.
- Special Investigation course can be taken under ENGR 590—Special Investigations in Engineering Science, and only 3 hours can be counted towards the minimum required 26 semester hours of course work.
- Students with an M.S. degree in Physics must take at least 9 hours of ENGR courses, one of which can be ENGR 590.
- Students with an M.S. degree in Physics from SIUC can substitute PHYS 500A and 500B Mathematical Physics for six hours of math requirement in program core.
- Transfer credit will normally be given for some of the graduate level courses suitable to the program upon review by the college Ph.D. Committee. Proficiency examinations may be authorized by the committee for areas in which questions of transfer credit arise. No credit will be given for industrial experience. A maximum of six hours of course work can be transferred in all cases due to residency requirement, which states that every student must complete at least 24 semester hours of approved course work at SIUC prior to taking the candidacy examination. Of the 24 hours, only 6 hours can be dissertation (ENGR 600) hours before candidacy.
- A student transferring credits from a master's program must have earned those credits over and above the required course work to obtain the M.S. degree in his/her institution. Credit cannot be transferred from master degrees obtained from international institutions.

### Candidacy

A Ph.D. student must satisfy all Graduate School requirements to become a candidate. Acceptance to Ph.D. candidacy is contingent upon the completion of all core courses with A or B grades and successful completion of a written and an oral test in the student's area of concentration. A student who obtains a grade lower than B in any

core course is allowed to repeat that course at most one more time in order to secure at least a B in the second attempt. After the second attempt, if a student fails to secure the minimum B grade in a core course, he/she will not be accepted to candidacy in the engineering science Ph.D. program. In extenuating circumstances, however, the student may petition, through their advisor, to the Director of the Program, Associate Dean of the College, for reassessment of his/her performance.

The examination in the area of concentration is organized and administered by the student's academic advisor. The candidacy examination committee consists of at least three faculty chosen by the advisor in consultation with the student. The committee has to be approved by the program director before it conducts the examination. Normally, the examination can be conducted at any time during the year when classes are in session. In the written examination, the student is tested in at least two major topics of the area of concentration with an appropriate number of questions prepared by the members of the student's candidacy committee. Each student has to score at least 70% in each major topic test in order to successfully complete the written part of the candidacy examination. If a student fails to pass any topic test of the written examination, a second chance is given for the failed topic test. If a student does not successfully complete the written examination after two attempts, he/she will not be accepted to candidacy in the engineering science Ph.D. program. A student is qualified to take the oral examination only after successfully completing the written examination.

The oral examination is conducted within two weeks of the successful completion of the written examination. In the oral examination, the student is tested again in the area of concentration by at least three candidacy committee members. If a student fails to pass the oral examination in the first attempt, a second chance is given. If a student does not successfully complete the oral examination after two attempts, he/she will not be accepted to candidacy in the engineering science Ph.D. program.

After the completion of the concentration examination, copies of the graded tests, along with signoff sheets for both the written and oral examinations are submitted to the director of the Ph.D. program, who is also the Associate Dean of the College.

### **Dissertation**

A dissertation must be written under the direction or co-direction of an engineering faculty member and approved by a dissertation committee consisting of a minimum of five members, one of whom must be from outside the College of Engineering. For students with physics background the committee will be made up of at least six members, three cross-appointed Physics faculty members and three Engineering faculty members, with a chair from Physics and a co-chair from Engineering.

The dissertation adviser must be chosen by the end of the student's first academic year. The dissertation committee must be formed no later than immediately after successful completion of the candidacy examination. The members of this committee need not be the same as the members of the candidacy examination committee.

A dissertation research proposal must be approved by the dissertation committee. Candidates will be required to present an acceptable dissertation describing original research performed with minimal supervision.

Dissertation approval is based on a successful oral defense of the dissertation research and approval of the dissertation. This requires approval of at least 80 percent of the dissertation committee.

### **Graduation**

1. All requirements of the Graduate School must be met.
2. A minimum of 26 hours of doctoral level course work must be completed with a minimum grade point average of 3.25.
3. An acceptable dissertation must be completed within five years after admission to candidacy or the student will be required to repeat the candidacy examinations.

### **Master of Science Programs**

See Civil Engineering, Electrical Engineering, Manufacturing Systems, Mechanical Engineering, or Mining Engineering

### **Courses (ENGR)**

**521-3 Probability and Stochastic Processes for Engineers.** Axioms of probability, random variables and vectors, joint distributions, correlation, conditional statistics, sequences of random variables, stochastic convergence, central limit theorem, stochastic processes, stationarity, ergodicity, spectral analysis, and Markov processes.

**530-3 Engineering Data-Acquisition: Theory and Practice.** Theory of data acquisition and measurement systems. Criteria for selection of data acquisition hardware and software, instruments, sensors and other components for scientific and engineering experimentation. Methods for sampled data acquisition, signal conditioning, interpretation, analysis, and error estimation.

**540-3 Design of Engineering Experiments.** Planning of experiments for laboratory and field studies, factorial designs, factorial designs at two levels, fractional factorial designs, response surface methods, mixture designs. Prerequisite: Mining Engineering 417, or Mathematics 483, or equivalent, or consent of instructor.

**545-3 Advanced Numerical Methods in Engineering.** Engineering applications of linear and nonlinear equations, eigenvalue problems, interpolation and approximating functions and sets of data, numerical solutions of ordinary

and partial differential equations. Prerequisite: 222 or equivalent, 351 or equivalent, and Mathematics 305 or consent of instructor.

**550-3 to 9 (Maximum of 3 per topic) Advanced Topics in Mechanics.** Topics will be offered in fluid mechanics, solid mechanics, structures, or materials. Advanced topics in fluid mechanics include: **(a)** Turbulence modeling, **(b)** Fluid transients, **(c)** Flow through porous media, and **(d)** Rheology. Advanced topics in solid mechanics include: **(e)** Theory and analysis of shells, **(f)** Theory of elasticity, **(g)** Viscoelasticity. Advanced topics in structure include: **(h)** Structural dynamics, **(i)** Nonlinear structural analysis. Advanced topics in materials include: **(j)** Fracture mechanics and dislocation theory **(k)** Advanced rock mechanics, and **(l)** Numerical methods in geomechanics. Prerequisite: consent of instructor.

**551-3 to 9 (Maximum of 3 per topic) Advanced Topics in Fossil Energy.** Studies of fossil energy extraction and conversion process with emphasis on scientific principles, analytical methods, and recent technological developments. Topics include: **(a)** physical coal processing, **(b)** fine coal beneficiation, **(c)** coal chemistry and characterization, **(d)** environmental issues of air and hazardous waste, **(e)** advanced mining systems, **(f)** network theory in mine ventilation, **(g)** operations research applications to mining, **(h)** solid carbon and coal derived materials. Prerequisite: consent of instructor.

**580-1 Seminar.** Study and oral presentation of selected problems in advanced engineering and science. Graded *S/U* only. Prerequisite: enrollment in the Ph.D. in engineering science program and consent of instructor.

**590-1 to 3 Special Investigations in Engineering Science.** Investigation of individual advanced projects and problems selected by student or instructor. Prerequisite: admission into Ph.D. program in engineering science.

**600-1 to 24 (1 to 16 per semester) Doctoral Dissertation.** Dissertation research. Hours and credit to be arranged by director of graduate studies. Graded *S/U* only. Prerequisite: admission to Ph.D. in engineering science program.

**601-1 per semester Continuing Enrollment.** For those graduate students who have not finished their degree programs and who are in the process of working on their dissertation, thesis, or research paper. The student must have completed a minimum of 24 hours of dissertation research, or the minimum thesis, or research hours before being eligible to register for this course. Concurrent enrollment in any other course is not permitted. Graded *S/U* or *DEF* only.