

Engineering

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COLLEGE OF ENGINEERING

SIU Carbondale Faculty participating in the Engineering Science Ph.D. Program are listed below:

Civil and Environmental Engineering (CEE) Faculty:

Bravo, Rolando, Associate Professor, Ph.D., University of Houston, 1990; 1991. Surface and subsurface hydrology, hydraulics and fluid mechanics.

Chevalier, Lizette R., Professor, *Associate Dean*, Ph.D., Michigan State University, 1994; 1995. Environmental restoration of groundwater aquifers, experimental investigation of immiscible flow, and numerical modeling of subsurface transport.

DeVantier, Bruce A., Associate Professor, Ph.D., University of California-Davis, 1983; 1983. Water quality modeling, sediment transport, turbulence modeling, finite element methods.

Hsiao, J. Kent, Associate Professor, Ph.D., University of Utah—Salt Lake City, 2000; 2001. Structural earthquake engineering, structural reliability, structural design of buildings and bridges using steel, reinforced or prestressed concrete, masonry, and wood.

Kalra, Ajay, Assistant Professor, Ph.D., University of Nevada, 2011; 2015. Hydraulics and Water Resources Engineering, hydro-climatology, urban sustainability, water-energy-climate nexus, probabilistic forecasting and downscaling, surface water and groundwater interactions.

Kassimali, Aslam, Professor and *Distinguished Teacher*, Ph.D., University of Missouri, 1976; 1980. Structural engineering, nonlinear structural analysis, structural dynamics and stability.

Kolay, Prabir, Associate Professor, Ph. D., Indian Institute of Technology, IIT Bombay, 2001; 2010. Geotechnical Engineering, Soil Stabilization, Unsaturated Soil, ANN Modeling.

Kumar, Sanjeev, Professor, *Distinguished Teacher and Chair*, Ph.D., University of Missouri-Rolla, 1996; 1998. Dynamic soil-structure interaction, piles under lateral loads, settlement prediction of landfills, hydraulic conductivity of clay barriers, seismic analysis and design of landfills, ground motion amplification in soils, liquefaction of silts and sands and machine foundations.

Liang, Yanna, Associate Professor, Ph.D., Utah State University, 2006; 2007. Bioremediation of organic pollutants in subsurface and groundwater, bioenergy production from alternative sources, and biomaterial production from biological processes.

Liu Jia, Assistant Professor, Ph.D., University of Houston, 2014; 2015. Environmental Engineering, renewable energy production, microbial fuel cell, water/wastewater treatment and groundwater/soil remediation, material development for energy safety and environmental pollution detection.

Puri, Vijay K., Professor, Ph.D., University of Missouri-Rolla, 1984; 1986. Geotechnical engineering, soil dynamics, machine foundations, liquefaction of soils.

Tezcan, Jale, Associate Professor, Ph.D., Rice University,

2005; 2005. Non-linear structural behavior, neural networks In system Identification and structural control, rehabilitation, and retrofitting of structures damaged by earthquakes.

Warwick, John J., Professor and *Dean of Engineering*, Ph.D., Penn State University, 1983; 2011. Environmental engineer, surface water hydrology, surface water quality simulation.

Electrical and Computer Engineering (ECE) Faculty:

Although ECE has its own PhD program, prospective students continue to have ECE concentration available if they want to pursue their PhD degree in Engineering Science.

Ahmed, Shaikh S., Professor, Ph.D., Arizona, 2005; 2007. Nanotechnology, semiconductor devices and circuit design, simulation and characterization.

Ahmadi, Reza, Assistant Professor, Ph.D., Missouri University of Science and Technology, 2013. Power electronics & energy conversion, renewable energy harvesting, hybrid electric vehicles, smart grid.

Chen, Ying (Ada), Associate Professor, Ph.D., Duke, 2007; 2007. Biomedical imaging, image reconstruction, digital tomosynthesis, image quality analysis, signal and image processing, simulation and computing.

Gupta, Lalit, Professor, Ph.D., Southern Methodist University, 1986; 1986. Computer vision, pattern recognition, digital signal processing, neural networks.

Haniotakis, Themistoklis, Associate Professor, Ph.D., University of Athens, 1998; 1998. Digital VLSI Design and Test, RF IC Design and Test, Low Power VLSI Design, Fault-tolerant Systems.

Harackiewicz, Frances J., Professor, Ph.D., University of Massachusetts-Amherst, 1990; 1989. Electromagnetics, antenna theory and design, microwaves, microstrip phased arrays and anisotropic materials.

Hatziadoniu, Konstantine, Professor, Ph.D., West Virginia University, 1987; 1987. Power systems modeling, simulation and control, high voltage DC transmission, power electronics, power systems transient.

Kagaris, Dimitrios, Professor, Ph.D., Dartmouth College, 1994; 1995. VLSI design automation, digital circuit testing, communication networks.

Qin, Jun, Assistant Professor, Ph.D. Duke University, 2008. Medical device development, instrumentation and sensors, medical data acquisition and analysis, medical acoustics, therapeutic ultrasound, haptics.

Sayeh, Mohammad R., Professor, Ph.D., Oklahoma State University, 1985; 1986. Neural networks, optical computing, image processing, stochastic modeling, quantum electronics.

Tragoudas, Spyros, Professor and *Chair*, Ph.D., University of Texas at Dallas, 1991;1999. Design automation for VSLI, testing and verification of digital circuiting, computer networks.

Wang, Haibo, Professor, Ph.D., University of Arizona, 2002; 2002. Mixed-signal VLSI design and testing, digital VLSI, VLSI design automation.

Weng, Ning, Associate Professor, Ph.D., University of Massachusetts at Amherst, 2005; 2005. High performance routers, network processors, system-on-a-Chip, computer architectures.

Zhou, Xiangwei, Assistant Professor, Ph.D., Georgia Institute of Technology, 2011. Wireless communications, statistical

signal processing, cross-layer optimization, cognitive radio, smart grid.

Mechanical Engineering and Energy Process (MEEP) Faculty:

Abrate, Serge, Professor, Ph.D. Purdue University, 1983; 1995. Impact, penetration, structural dynamics, composites.

Agrawal, Om, Professor, Ph.D., University of Illinois-Chicago, 1984; 1985. Computer-aided analysis and design of rigid/flexible multibody systems, numerical analysis, finite element methods, and continuum mechanics, CAD/Simulation of mechanical systems.

Chu, Tsuchin P., Professor, Ph.D., University of South Carolina, 1982; 1990. CAD/ CAM, imaging systems, mechanical vibrations, computer graphics, machine vision, optical methods in experimental mechanics and manufacturing, image processing.

Cooley, Christopher, Assistant Professor, Ph.D., Ohio State University, 2006; 2012. Dynamics, vibration, and stability of high-speed mechanical systems; gear system dynamics and vibration.

Don, Jarlen, Professor, Ph.D., Ohio State University, 1982; 1985. Materials creep and creep fatigue, surface phenomena, carbon-carbon composites, composite materials, friction materials.

Esmaceli, Asghar, Professor, Ph.D., University of Michigan, 1995; 2000. CFD, two-phase heat transfer.

Farhang, Kambiz, Professor, Ph.D., Purdue University, 1989; 1990. CAD/CAM, controls, vibrations, kinematics, dynamics, control and stability of flexible and rigid-body mechanical, electromechanical, mechanical-drive systems; manufacturing processes and process control.

Filip, Peter, Professor, Ph.D., Technical University Ostrava, Czech Republic, 1989; 2004. Friction materials, biomaterials.

Koc, Rasit, Professor and *Chair*, Ph.D., University of Missouri-Rolla, 1989; 1994. Ceramic materials, powder processing, nonstoichiometry of oxides; sintering of oxide and non-oxide ceramics, methods preparing high purity oxides from organometallics, perovskites for use as high temperature electrodes, synthesizing submicron carbide, nitride and boride powders.

Mathias, James A., Associate Professor, Ph.D., Ohio State University, 2001; 2003. Nanotechnology, microchannels, heat transfer, thermodynamics, energy utilization.

Mondal, Kanchan, Professor, Ph.D., SIU, 2001; 2006. Electrochemistry, energy from coal, catalysis, reactor systems and design.

Nsofor, Emmanuel C., Professor, Ph.D., Mississippi State University, 1993; 1999. Experimental and computational flow and heat transfer, advanced energy systems, HVAC & R, energy storage, environmental engineering, thermodynamics and combustion.

Suni, Ian I., Professor and *Director of the Materials Technology Center*, Ph.D., Harvard University, 1992; 2013. Application of electrochemistry and electrochemical engineering to technology advancement in thin film growth and dissolution, including both photovoltaic thin films and ULSI materials; electrochemical biosensors, including the use of electrochemical impedance spectroscopy (EIS) for detecting antibody-antigen recognition; and nanotechnology, including the use of nanoporous template

materials for alternative energy development and biosensing.

Wiltowski, Tomasz, Professor and *Director of the Advanced Coal and Energy Research Center*, Ph.D., Institute of Catalysis and Surface Chemistry, Cracow, Poland, 1982; 2003. Coal transformation and characterization, coal gasification, alternative energy sources, hydrogen production from coal, catalytic conversion of hydrocarbons and alcohols to hydrogen, fuel cells, nanomaterials synthesis and characterization.

Mining and Mineral Resource Engineering (MMRE) Faculty:

Chugh, Yoginder P., Professor, Ph.D., Pennsylvania State University, 1971; 1977. Coal combustion byproduct utilization and management, rock mechanics and ground control.

Harpalani, Satya, Professor, Ph.D., University of California, Berkeley, 1985; 2002. Mine ventilation, coal bed methane reservoir engineering, in situ mining, and carbon dioxide sequestration.

Mohanty, Manoj, Professor, Ph.D., Southern Illinois University Carbondale, 1997; 2000. Coal and mineral processing, experimental design and statistical analysis.

Paul, Bradley, Associate Professor, Ph.D., University of Utah, 1989; 1990. Underground mining systems and solution mining, minerals processing, hard rock and industrial minerals, geostatistics, mine environmental studies.

Spearing, A.J.S. (Sam), Associate Professor, *Emeritus*, Ph.D., Technical University of Silesia, 1993; 2007. Mine design, rock mechanics, backfill, strata control and risk assessment.

COLLEGE OF ENGINEERING—SIU Edwardsville Faculty: participating in the Engineering Science Ph.D. Program (see below)

Graduate Faculty (SIU Edwardsville):

Alkin, Oktay, Ph.D., Professor, University of Alabama, 1986.
Azambuja, Marcelo, Ph.D., Assistant Professor, University of Texas at Austin, 2009.

Bouvier, Dennis J., Ph.D., Associate Professor, University of Louisiana at Lafayette, 1994.

Celik, Serdar, Ph.D., Associate Professor, Southern Illinois University Carbondale, 2007.

Chen, Jen-Shiun, Ph.D., Professor, Ohio State University, 1983.

Chen, Xin, Ph.D., Assistant Professor, Purdue University, 2009.

Cho, Sohyung, Ph.D., Associate Professor, Pennsylvania State University, 2000.

Crk, Igor, Ph.D., Assistant Professor, University of Arizona in Tucson, 2010.

Cross, Brad, Ph.D., P.E., S.E., Professor, Johns Hopkins University, 1992.

Eneyo, Emmanuel S., Ph.D., Professor, Purdue University-West Lafayette, Indiana, 1991.

Engel, George L., D.Sc., Professor, Washington University, 1990.

Ercal, Gunes, Ph.D., Assistant Professor, University of California, Los Angeles, 2008.

Fries, Ryan, Ph.D., P.E., Associate Professor, Clemson University, 2007.

Fujinoki, Hiroshi, Ph.D., Associate Professor, University of Southern Florida, 2001.

Gordon, Chris, Ph.D., Associate Professor, Carnegie Mellon University, 2006.

Gu, Keqin, Ph.D. Professor, Georgia Institute of Technology, 1988.

Huang, Jianwei, Ph.D., Assistant Professor, Syracuse University, 2010.

Karacal, Seref C., Ph.D., Professor and *Associate Dean*, Oklahoma State University, 1991.

Ko, Hoo Sang, Ph.D., Assistant Professor, Purdue University, 2010.

Krauss, Ryan, Ph.D., Associate Professor, Georgia Institute of Technology, 2006.

Kweon, Soondo, Ph.D., Assistant Professor, University of Illinois at Urbana-Champaign, 2009.

LeAnder, Robert W., Ph.D., Associate Professor, University of Illinois at Chicago, 2002.

Lee, Heungsoon F., Ph.D., Professor, University of Michigan, 1989.

Lozowski, Andy G., Ph.D., Associate Professor, University of Louisville, 1999.

Luo, Albert, Ph.D., Professor, University of Manitoba-Winnipeg, 1996.

Mayer, Gary R., Ph.D., Assistant Professor, Arizona State University, 2009.

McKenney, Mark, Ph.D., Assistant Professor, University of Florida, 2008.

Molki, Majid, Ph.D., Professor, University of Minnesota, 1982.

Morgan, Susan, Ph.D., P.E., Professor, Clemson University, 1995.

Noble, Brad, D.Sc., Associate Professor, Washington University, 2000.

Osouli, Abdolreza (Reza), Ph.D., Assistant Professor, University of Illinois at Urbana-Champaign, 2009.

Qi, Yan, Ph.D. Assistant Professor, Louisiana State University, 2010.

Sevim, Hasan, Eng, Sc.D., Professor and *Dean*, Columbia University, New York, 1984.

Shang, Ying, D. Eng., Associate Professor, University of Notre Dame, 2006.

Smith, Scott R., Ph.D., Professor, University of Illinois, 1991.

Umbaugh, Scott E., Ph.D., Professor, University of Missouri Rolla, 1989.

Wang, Fengxia, Ph.D., Assistant Professor, Purdue University, 2008.

Weinberg, Jerry B., Ph.D., Professor, Vanderbilt University, 1996.

Werner, Anne, Ph.D., Assistant Professor, University of Illinois at Urbana-Champaign, 2004.

White, William W., Ph.D., Professor, Ohio State University, 1989.

Yan, Terry, Ph.D., Professor, University of California at Davis, 1993.

Yu, Xudong W., Ph.D., Associate Professor, Vanderbilt University, 1994.

Zhou, Jianpeng (Jim), Ph.D., P.E., Associate Professor, University of British Columbia, 2003.

The College of Engineering offers graduate programs leading to the Master of Science degree in civil engineering, electrical engineering, mechanical engineering, mining engineering, and quality engineering and management and a Doctor of Philosophy degree in engineering science and electrical and computer engineering. 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 Advanced Coal and Energy Research Center, the Materials Technology Center, and the Office of Sponsored Projects Administration.

Doctor of Philosophy in Engineering Science

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

Areas of Concentration

Civil and Environmental Engineering. Course offerings and research activities include water and wastewater treatments, hazardous and industrial waste treatment, geotechnical and geoenvironmental engineering, hydrologic and hydraulic engineering, sediment transport, water resources engineering, steel and concrete design, structural analysis, seismic design and analysis, and engineering materials.

Electrical and Computer Engineering. Course offerings and research activities include antennas, circuits and systems theory, electromagnetics, robust and adaptive control, robotics, embedded control, MEMS, nanoelectronics, energy conversion, power systems, power electronics, pattern recognition, image processing, biomedical engineering, neural networks, optical computing, stochastic modeling, wireless communications, detection and estimation theory, communication networks, mobile ad hoc networks, sensor networks, digital systems, programmable ASICs design, bioengineering, computer architecture, CMOS VLSI, fault tolerance, mixed signal testing and design, low power system design, hardware/software co-design, synthesis and verification of digital systems, physical design automation, and VLSI testing.

Industrial and Quality Engineering. Course offerings and research activities include quality assurance, statistical process control, six sigma, lean enterprise, service quality, reliability analysis, quality function deployment, design of experiments, project management, human safety, risk management, management of information technology resources, energy management and conservation.

Mechanical Engineering and Energy Processes. Course offerings and research activities include mechanics, mechanical systems, fractional calculus and their applications, fluid/thermal systems, material and chemical systems, air pollution control, mass and heat transfer, coal conversion, electrochemical processes, catalysis, thermal science, thermal systems design, combustion, internal combustion engines, chemical and biochemical processes, dynamics and vibrations, mechanical systems control, computational modeling and simulations, composite materials and ceramics, tribology, and micro- and nano-technology, electro-hydrodynamics, computational multiphase flow and heat transfer, microfluidics, bio-fluidics, CFD, computations of phase change phenomena and capillary driven flows.

Mining and Mineral Resources Engineering. Course offerings and research activities in this area of concentration include rock mechanics and ground control, geological engineering, mineral and coal processing, surface and underground mining systems performance optimization, mine design innovative mining systems, surface mine reclamation, in-situ mining, mine environment and ventilation, coal mine dust control, coal bed methane reservoir engineering, carbon dioxide sequestration, and coal combustion byproduct utilization and management.

Cooperative Ph.D. Program

The College of Engineering at SIU-Carbondale and SIU-Edwardsville have entered into a cooperative Ph.D. program in Engineering Science which enables students to do work on both campuses. Additional information may be obtained at <http://www.siu.edu/engineering/phd/>

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. This program requires a \$65.00 application fee that must be submitted with the application for Admission to Graduate Study in Engineering Science.

In addition to Graduate School and other college requirements, the committee ordinarily requires a grade point average of 3.25 (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 minimum TOEFL score of 550 (paper score) or 213 (computer score) or 80 (internet score) or an IELTS score of 6.5 or higher for admission.

Admission to the doctoral program also requires the identification of an initial graduate adviser for each student. For students seeking admission to the Cooperative Ph.D. Program, both an initial SIU-Edwardsville advisor along with an initial SIU-Carbondale co-advisor must be identified. 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 a minimum of 18 hours of approved coursework with a minimum GPA of 3.75, a student may request for an accelerated entry into the Ph.D. program. Such entry is permitted only to superior students who have exhibited evidence that they are prepared to begin the research activities of doctoral-level study. In addition, the student must have GRE scores that are at or above the 50th percentile for both verbal component and analytical essay component and 80th percentile for the quantitative component or a combined total percentile score of 180 or higher. In case of a

domestic student, an undergraduate GPA of 3.5 or higher is also a requirement. For an international student, a TOEFL score of 550 (paper score) or an IBT score of 80 or an IELTS score of 6.5 is an additional requirement. In exceptional cases, to substitute for the abovementioned GRE and TOEFL score requirements, the student's current faculty advisor, with the approval of the department chair, may submit a letter of recommendation for his/her student's accelerated entry into the PhD program.

The student, having an accelerated entry into the Ph.D. program may not write a M.S. Thesis. In addition, 6 credit hours of course work of 500 level completed prior to his/her entry into the Ph.D. program may be counted toward the PhD course requirement. In the rare event that the student getting an accelerated entry into the Ph.D. Program fails to pass the Ph.D. qualifying exam in two attempts, he/she will be allowed to complete a MS degree in his/her respective discipline.

Computer Science. Based on a memorandum of understanding signed between the College of Engineering and the College of Science, the Department of Computer Science 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 Computer Science faculty serves on the Committee. An M.S. in Computer Science 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.

It is recommended that the seminar classes be taken after the initiation of doctoral research or after candidacy is granted. 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.
- 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 SIU prior to taking the candidacy examination. Of the 24 hours of dissertation research (ENGR 600) only 6 hours can be completed 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 courses, excluding the seminar, with *A* or *B* grades and successful completion of a written and an oral examination in the student's area of concentration.

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 the 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.

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 a computer science background, the committee will be made up of at least six members, three cross-appointed Computer Science faculty members and three Engineering faculty members, with a chair from Computer Science and a co-chair from Engineering. For students enrolled in the cooperative Ph.D. program, the committee will be made up of at least six members, three SIUC faculty members and three SIUE faculty members, with a chair from SIUE and a co-chair from SIUC.

The dissertation adviser must be chosen by the end of the student's first academic year. The dissertation committee should be formed 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.

Doctor of Philosophy in Electrical and Computer Engineering

See Electrical Engineering

Master of Science Programs

See Civil Engineering, Electrical Engineering, Quality Engineering and Management, Mechanical Engineering, or Mining Engineering

Courses (ENGR)

521-3 Probability and Stochastic Processes for Engineers.

(Same as ECE 551) 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. Restricted to graduate

student status.

522-3 Intellectual Property and Commercialization. (Same as LAW 633 and BA 537) Course teaches substance and practice of commercializing context and how those laws are applied in various fields of technology. Will learn how to value intangible assets, taking into account their commercial potential and legal status. Course will consider the legal and business issues surrounding marketing of products of research. Will prepare and negotiate license agreements. Will analyze legal and business issues surrounding whether and how to enforce intellectual property rights. Content and methods of course delivery and evaluation has been approved for provision by distance education.

530-3 Engineering Data Acquisition: Theory and Practice. (Same as ECE 530) 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. Project-based fee: \$60 to help defray cost of software licenses and equipment.

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: MNGE 417, or MATH 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: ENGR 222 or equivalent, 351 or equivalent, and MATH 305 or consent of instructor.

580-1 Seminar. Study and presentation of research topics from students' own specialty areas within engineering and science. Graded *S/U* only. Restricted to: enrollment in the Ph.D. in engineering science program or consent of instructor.

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

592-1 to 3 Engineering Cooperative Education. Supervised work experience in industry, government or in a professional organization. Work must be directly related to student's program of study. Student works with on-site supervisor and faculty advisor. Activity report is required from the student and performance report is required from the employer. Enrollment requires Chair's approval. Hours do not count toward degree requirements. Mandatory Pass/Fail. Restricted to graduate standing.

593-3 Special Topics in Engineering. Studies of various special topics in the area of engineering science. Special approval needed from the instructor.

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. Restricted to 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.