Division of Engineering - Electircal Engineering
Message from the Division Director

Engineering has historically been a field that applies scientific knowledge to the needs of society by producing technological dev-ices and systems. As the complexity in our society grows along with improvements in lifestyle and an increase in world population, technology becomes imbedded more deeply into the fabric of all of our lives. For the engineer this translates directly into technology-based demands, opportunities and challenges.

Graduate education is increasingly critical to today's engineer as the technologies that are addressed become more complex and the tool-set used to analyze problems and produce solutions becomes more technically and computationally intensive. What was a solitary endeavor at a computer, a drafting table, or a work site has become a team activity requiring diverse interdisciplinary skills.

Today's engineers must be aware of modern techniques of measurement, analysis, and interpretation. They should be able to exploit sophisticated control systems and instrumentation, be familiar with advanced numerical modeling techniques and recent developments in engineering software and computer architecture, and have a good knowledge of data acquisition, processing, and visualization methods.

The Engineering graduate degree structure at CSM builds upon the foundation of an undergraduate engineering degree to produce a highly capable engineer with these qualities and specialization in the field of his or her choice.

The graduate program in Engineering at CSM started in 1994 and offers a range of degrees to reflect the diversity of student ambitions and needs. Degrees are offered in Engineering Systems with optional specialization in Civil, Electrical, or Mechanical Engineering. Engineering Systems is constructed to provide an element of interdisciplinarity while facilitating the specialization that is critical to a graduate endeavor. Master of Science degrees can be constructed in a thesis or non-thesis format according to student needs; the traditional Doctor of Philosophy (Ph.D.) is also offered and emphasizes the classic depth of knowledge associated with state-of the art research.

Areas of specialization within the Engineering Division are centered around the civil, electrical, and mechanical disciplines with significant research activity that spans more than one field. Significant research areas are energy and power systems, biomechanics and engineering, energy conversion and fuel cell development, controls and control systems, mechanics and nano-mechanics, geotechnical engineering, and structural engineering.

The strength of the education provided by CSM Engineering Division is the Faculty and the teaching and research interaction that they provide with graduate students. Any member of the faculty will be glad to talk with you regarding your educational aspiratio ns and plans and I would be happy to answer any question that you might have. Please come and visit Engineering at CSM as you consider the next step in your education.

Terry Parker, Professor and Division Director
tparker@mines.edu
Engineering Division
Colorado School of Mines
Golden, Colorado 80401
Phone: 303-273-3650
FAX: 303-273-3602
http://egweb.mines.edu
http://egweb.mines.edu/faculty/TParker-Primary/TP_home_page_4.htm

Neal Sullivan, Assistant Professor
Mechanical Engineering Graduate Recruiting Coordinator
nsulliva@mines.edu
Phone: 303-273-3656

The Engineering Systems program offers a graduate multidisciplinary education with the option of including a specialization in one of the three disciplines: civil, electrical, or mechanical engineering. The program demands academic rigor and depth, yet also addresses the real-world problems of advanced engineering and technology. The choice of research topics and course offerings prepares graduates for a range of industrial or academic careers. The Division currently has over 50 Masters and 20 PhD candidates and carries a graduate student-to-faculty ratio of just over 2 to 1.

Research Overview

The Division of Engineering is always on the cutting edge of research. Whether through university, corporate, or student sponsored projects, the School of Mines is one of the leading engineering research facilities in the country. Much of the research occurs at the intersections of the traditional civil, electrical, and mechanical engineering disciplines. It is also common to pursue research and education that is at the intersections of the other disciplines represented at CSM, including chemical engineering, earth sciences, environmental science, materials science, or physics. Our main research focus lies in the following six areas.

Sensing, Communications and Control

Sensing, Communications and Control is an interdisciplinary research area that includes problems in robotics, mechatronics, intelligent structures and geosystems, energy and power, materials processing, telecommunications, bioengineering, mining and construction. Participating graduate students come from a variety of backgrounds, and may specialize in civil, mechanical or electrical engineering systems.

Geotechnical Engineering

Geotechnical Engineering has current activity in computational and analytical geomechanics, probabilistic geotechnics, experimental and theoretical investigations into coupled flows and unsaturated soil behavior, and intelligent geo-systems including geo-construction sensing and automation. The geotechnical faculty and students work primarily within the Civil Specialty of the Engineering Systems graduate programs; however, strong interdisciplinary ties are maintained with other groups in Engineering and with other departments at CSM.

Material Mechanics

Material Mechanics investigations consider solid-state material behavior as it relates to microstructural evolution and control, nano-mechanics, functionally graded materials, biomaterial analysis and characterization, artificial biomaterial design, and fracture mechanics. Research in this area tends to have a strong computational physics component covering a broad range of length and time scales that embrace ab initio calculations, molecular dynamics, Monte Carlo and continuum modeling. These tools are used to study metallic and ceramic systems as well as natural biomaterials. Strong ties exist between this group and activities within the campus communities of physics, materials science, mathematics and chemical engineering.

Energy Systems and Power Electronics

Energy Systems and Power Electronics studies emphasize industrial issues associated with power, power electronics and renewable energy systems. Research and teaching embrace intelligent control systems, fuzzy control, real-time monitoring and advanced diagnostic systems, transformer and breaker monitoring, smart substations, power quality, advanced power electronics, and remote sensing, security, and control.

Structural Engineering

Structural Engineering focuses on frontier, multidisciplinary research in the following areas: high strength and self consolidating concrete, experimental and computational structural dynamics, vibration control, damage diagnosis, and advanced data processing and analysis for sensory systems, disaster assessment and mitigation, and structural nondestructive evaluation and health monitoring.

Fluid Mechanics and Thermal Sciences

Fluid Mechanics and Thermal Sciences is a research area with a wide array of multidisciplinary applications including clean energy systems, materials processing, combustion, and bioengineering. Graduate students in this area typically specialize in Mechanical Engineering but also have the opportunity to specialize in interdisciplinary programs such as Material Sciences.

Degree Programs

The Division of Engineering offers a Master of Science and Doctor of Philosophy in Engineering Systems with specialties in civil, electrical or mechanical engineering. The *MS degree (thesis or non-thesis option)* requires 36 credit hours.

The *Ph.D. program* requires 72 credit hours beyond the bachelor's degree. Transfer credit can be awarded for previous graduate level coursework or an earned research based master's degree upon approval of the Division. All doctoral students must pass a qualifying examination, which is intended to gauge the student's capability to pursue research in Engineering Systems. Normally, Ph.D. students will take the qualifying examination in their first year, but it must be taken within three semesters of entering the program.

Within 18 months after passing the qualifying examination, the Ph.D. student must prepare a written thesis proposal and present it formally to the committee and other interested faculty. Students must then successfully write and defend a dissertation of his/her research.

Specific degree requirements by specialty are listed below.

Engineering Systems - No Specialty

Graduate students in Engineering Systems may elect not to declare a specialty. These students, whether masters or doctoral, must complete a core curriculum:

- EGES 501 Advanced Engineering Measurements (4 cr)
- EGES 502 Interdisciplinary Modeling and Simulation (4 cr)
- EGES 504 Engineering Systems (Any Specialty) Seminar (1 cr)

In addition to the above core, masters (non-thesis) students must take 27 credits of approved technical electives to complete their program. Masters (thesis option) students complete 15 hours of approved technical electives, 12 hours of research, and write and defend a thesis. To complete a doctoral program, students must take 15 credits in a minor area of study, 27 credits of technical electives, and 24 credits of research culminating in a doctoral dissertation.

Engineering Systems - Civil Specialty

There are two main emphasis areas within the Civil Engineering specialty: (1) geotechnical engineering, and (2) structural engineering; however thesis research activities will regularly overlap with the other emphasis areas within the Division. In addition to the Civil Engineering courses, technical electives will be available from other CSM departments such as Environmental Engineering, Geological Engineering and Mining, as well as Electrical and Mechanical courses from within the Engineering Division.

Civil Engineering students must complete EGES 504 - Egineering Systems (Civil) Seminar (1 credit). An additional three courses must be taken from the following list to complete the core:

- EGES 501 Advanced Engineering Measurements (4 cr)
- EGES 502 Interdisciplinary Modeling and Simulation (4 cr)
- EGES 533 Unsaturated Soil Mechanics (3 cr)
- EGES 534 Soil Behavior (3 cr)
- EGES 542 Finite Elements for Engineers (3 cr)
- EGES 548 Advanced Soil Mechanics (3 cr)
- EGES 550 Numerical Methods for Engineers (3 cr)
- EGES 598 Dynamics of Structures and Soils (3 cr)
- EGES 598 Advanced Structural Theory (3 cr)
- EGES 598 Advanced Concrete Design (3 cr)
- EGES 598 Advanced Foundations (3 cr)
- EGES 598 Experimental Structural Dynamics (3 cr)

Masters students must then complete technical electives in engineering or other disciplines as approved by their advisor - thesis option (14 credits), non-thesis option (26 credits). To complete the program, non-thesis students take 6 credits of independent study and thesis students take 12 credits of research leading to a master's thesis.

In addition to the core, doctoral students must complete 12 credits in a minor area of study, 26 credits of technical electives and 24 credits of research.

Engineering Systems - Electrical Specialty

Within the Electrical Engineering specialty, there are two emphasis areas: (1) Automation, Sensing and Communication, and (2) Energy Systems and Power Electronics. Students are encouraged to decide between the two before pursuing an advanced degree.

All students must complete EGES 504 - Engineering Systems (Electrical) Seminar (1 credit) and two courses from the list below. Four additional courses (12 credits) must be taken within one of the two emphasis areas.

- EGES 501 Advanced Engineering Measurements (4 cr)
- EGES 502 Interdisciplinary Modeling and Simulation (4 cr)
- EGES 503 Modern Engineering Design and Project Management (3 cr)
- EGES 550 Numerical Methods for Engineers (3 cr)
- EGES 515 Advanced Linear Systems (3 cr)
- EGES 598 Introduction to Stochastic Processes (3 cr)
- MACS 401 Real Analysis (3 cr)
- MACS 404 Artificial Intelligence (3 cr)
- MACS 407 Introduction to Scientific Computing (3 cr)
- MACS 500 Linear Vector Spaces (3 cr)
- MACS 506 Complex Analysis II (3 cr)
- MACS 514 Applied Mathematics I (3 cr)
- MACS 530 Statistical Methods I (3 cr)

Masters students must then complete technical electives as approved by their advisor - thesis option (5 credits), nonthesis option (17 credits). To complete the program, thesis students take 12 credits of research leading to a master's thesis.

In addition to the core, doctoral students must complete 12 credits in a minor area of study, 17 credits of technical electives and 24 credits of research.

Engineering Systems - Mechanical Specialty

Within the Mechanical Engineering specialty, there are two emphasis areas: (1) Material Mechanics, and (2) Thermal Sciences. Materials processing, materials simulation and process control are investigated from perspectives ranging from fundamental physical underpinnings to industrial application. Students are required to complete a set of core classes intended to prepare them for both theoretical and experimental aspects of research in the mechanical sciences. The program has strong ties to the chemical engineering, materials science and physics communities, and students will typically take courses in one or more of these areas after completing the core class requirements. The core program consists of the following classes:

- EGES 501 Advanced Engineering Measurements (4 cr)
- EGES 502 Interdisciplinary Modeling and Simulation (4 cr)
- EGES 504 Engineering Systems (Mechanical) Seminar (1 cr)

Additional courses are then selected from the Mechanical Engineering offerings - master's thesis (9 credits), master's non-thesis (21 credits), PhD (18 credits):

- EGES 503 Project Management (3 cr)
- EGES 517 Theory and Design of Advanced Control Systems (3 cr)
- EGES 518 Robot Mechanics (3 cr)
- EGES 521 Mechatronics (3 cr)
- EGES 523 Fatigue and Fracture (3 cr)
- EGES 535 Discrete Elements (3 cr)
- EGES 540 Continuum Mechanics (3 cr)
- EGES 542 Finite Element Analysis (3 cr)
- EGES 545 Boundary Element Analysis (3 cr)
- EGES 552 Viscous Flow and Boundary Layers (3 cr)
- EGES 566 Combustion (3 cr)
- EGES 573 Introduction to Computational Techniques for Fluid Dynamics and Transport Phenomena (3 cr)
- EGES 598 Atomistic Simulation (3 cr)
- EGES 515 Linear Systems Theory (3 cr)
- EGES 598 Multiple Phase Flows (3 cr)
- EGES 598 Introduction to Biomedical Engineering (3 cr)
- EGES 598 Musculoskeletal Biomechanics (3 cr)
- EGES 617 Intelligent Control (3 cr)
- EGES 619 Intelligent Structures (3 cr)
- EGES 642 Advanced Finite Elements (3 cr)
- EGES 659 Optical Measurements in Reacting and Nonreacting Flowfields (4 cr)
- EGES 698 Microstructural Evolution (3 cr)

To complete the program, all masters students must take 6 credits of technical electives as approved by their advisor. Additionally, thesis students take 12 credits of research leading to a master's thesis. Doctoral students must complete 12 credits in a minor area of study, 9 credits of technical electives and 24 credits of research.

Admissions/Entrance Requirements

The requirements for admission for the M.S. and Ph.D. degrees in Engineering Systems are a baccalaureate degree in engineering, computer science, a physical science, or math with a grade-point average over 3.0/4.0; Graduate Record Examination score of 650 (quantitative) and a TOEFL score of 550 or higher (paper based), 213 (computer based) for applicants whose native language is not English. Applicants from an engineering program at CSM are not required to submit GRE scores. The Engineering Graduate committee evaluating an applicant may require that the student take undergraduate remedial coursework to overcome technical deficiencies, which does not count toward the graduate program.

Applications for admission are accepted for both Fall and Spring enrollment. Complete applications are submitted to the Office of Graduate Studies and should include the following items:

- Official transcripts from all universities attended
- Three letters of recommendation
- Graduate Record Examination scores
- A personal statement indicating your goals and the reason you wish to attend CSM
- TOEFL scores (unless you hold a degree from an English speaking university).

For more information on graduate admissions requirements, and for the online application form, see Graduate Admissions (http://www.mines.edu/Admiss/grad/graduate_admissions.htm).

Western Regional Graduate Program

The M.S. and Ph.D. programs in the Division of Engineering are participants in the Western Regional Graduate Program (WRGP). This program offers students access to many high quality graduate programs at reduced costs. In most cases, WRGP students pay tuition at resident student rates. Students with residency in Alaska, Arizona, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming are eligible to participate in the WRGP. Students do not have to meet specific financial criteria, but they must meet all admissions requirements and deadlines set by CSM.

All students who indicate residency of one of these states on the admission application will automatically be included in this program. WRGP has been established by the Western Interstate Commission for Higher Education (WICHE) to promote the sharing of higher education resources among the western states listed above.

Financial Support

Financial aid is available to outstanding students through student teaching and research assistantships and fellowships. TA and RA contracts typically cover one academic year and most are awarded in the Fall. Awarding of all fellowships and assistantships is handled by the academic departments in conjunction with the admissions review process. The Application for Admission includes a section regarding financial support. Notification of financial awards is usually done at the time of admission notification.

Federal and CSM student loans are also available to give graduate students additional funding beyond any assistantships and fellowships they might receive. For more information, see Financial Aid (http://www.mines.edu/Admin/fin_aid).

Division of Engineering
Colorado School of Mines
Golden, CO 80401
Phone: 303-273-3650
FAX: 303-273-3602
URL: http://egweb.mines.edu

Division of Engineering – Electrical Faculty

Joel Bach, Assistant Professor. BS State University of New York at Buffalo; PhD University of California, Davis. Musculoskeletal, orthopedic, occupational and sports biomechanics. Techniques used range from mechanical testing to computer simulation and modeling.

John R. Berger, Associate Professor. BS, MS, PhD University of Maryland. Numerical modeling of cracks and crack growth; dynamic fracture; fracture toughness testing; interfacial fracture theory; measures of interfacial fracture toughness; interfacial bonding; electron beam moire; photoelasticity; strain gage methods.

D. Vaughan Griffiths, Professor. MS University of California, Berkeley; BSc, PhD, DSc University of Manchester, UK. Numerical and finite element modeling in geomechanics; geotechnical engineering.

William A. Hoff, Associate Professor. BS Illinois Institute of Technology; MS, PhD University of Illinois, Urbana-Champaign. Computer vision and image understanding; robotics; human-computer interfaces; computer graphics, virtual reality.

Robert J. Kee, George R. Brown Distinguished Professor of Engineering. BS University of Idaho; MS Stanford University; PhD University of California, Davis. Modeling and simulation of thermal- and fluid-based chemical processes; including combustion-derived pollution formation and abatement; and advanced materials manufacturing.

Robert H. King, Professor and Assistant Division Director. BS University of Utah; MS, PhD The Pennsylvania State University. Telerobotics for environmental remediation; robot health assessment; simulation of environmental remediation actions.

Panos D. Kiousis, Associate Professor. Diploma Democritus University of Thrace, Greece; PhD Louisiana State University. Earthquake engineering of high strength concrete; polymer modified concrete; ceramic composites; interface characteristics of dissimilar materials; finite elements; inelastic constitutive modeling; cemented soils.

Ning Lu, Associate Professor. BS Wuhan University of Technology; MS, PhD The Johns Hopkins University. Geotechnical engineering; environmental geotechnics; soil physics.

Mark T. Lusk, Associate Professor. BS U.S. Naval Academy; MS Colorado State University; PhD California Institute of Technology. Phase transitions; surface phenomena; material electromagnetics.

Michael Mooney, Associate Professor. BA Hastings College; BS Washington University; MS, PhD Northwestern University. Intelligent geo-systems (geostructural, geotechnical); infrastructure health monitoring; geoconstruction sensing and automation.

David R. Munoz, Associate Professor. BS University of New Mexico; MS, PhD Purdue University. Heat transfer and fluid mechanics; materials synthesis and design; fiber manufacturing; welding.

Graham G. W. Mustoe, Professor. BS, MS Aston University, England; PhD Swansea University, Wales. Modeling and simulation of engineering systems that exhibit complex combined continuum-discontinuum behavior; dynamic impact, fracture, ice mechanics; mechanics of granular media; materials processing.

Karl R. Nelson, Associate Professor. MS Colorado School of Mines; MS, PhD University of Colorado; Professional Engineer. Geotechnical engineering; hydrology; hydraulics.

Terence E. Parker, Professor and Director. BS, MS Stanford University; PhD University of California, Berkeley. Optical measurements in high-temperature and pressurereacting systems; combustion-generated pollutants; particle sizing and characterization using optical measurement techniques.

Paul Papas, Associate Professor. BS Georgia Institute of Technology; MA, PhD Princeton University. Linear stability analysis of reacting mixing layers; thermoacoustics, hydrodynamic and combustion instabilities; experimental laser diagnostics; non-premixed flame extinction and dynamics; high-temperature fuel oxidation kinetics; combustion thermodynamics-material synthesis and metal combustion.

P. K . S e n , Professor. BS Jadavpur University; MEng; PhD Technical University of Nova Scotia. Application of problems in power systems engineering; power system protection; insulation failure and equipment life; renewable energy; power engineering education.

Marcelo G. Simoes, Associate Professor. BS, MS, DSc University of Sao Paulo, Brazil; PhD University of Tennessee. Applications of intelligent, neural and fuzzy systems in power electronics and industrial systems.

Catherine K. Skokan, Associate Professor. BS, MS, PhD Colorado School of Mines. Digital signal processing; linear systems; electrical properties of earth materials; K-12
connections.

John P. H. Steele, Assistant Professor. BS New Mexico State University; MS, PhD University of New Mexico. Robotics and automation; intelligent machines; machine health monitoring; artificial intelligence; supervisory control; intelligent materials processing; neural networks.

Moneesh Upmanyu, Assistant Professor. Btech Indian Institute of Technology, Bombay; MS, PhD University of Michigan; PhD Princeton University. Modeling of materials at the atomistic and meso-scopic scales.

Tyrone L. Vincent, Assistant Professor. BS University of Arizona; MS, PhD University of Michigan, Ann Arbor. Nonlinear system identification and estimation; adaptive control; fault diagnosis.

Manoja Weiss, Assistant Professor. BSEE Grove City College; MSEE Pennsylvania State University; PhD University of Colorado.

Ray Ruichong Zhang, Associate Professor. BS, MS Tongji University, China; PhD Florida Atlantic University. Computational mechanics; structural dynamics; random vibrations; reliability of engineering systems; modeling of wave propagation.