UNIVERSITY OF SOUTH CAROLINA

Department of Mechanical Engineering

Program Overview (updated on Dec. 8, 2005)

Programs of Study

The Department of Mechanical Engineering offers graduate programs leading to the degrees of Master of Engineering (M.E.; non-thesis option), Master of Science (M.S.; thesis option), and Doctor of Philosophy (Ph.D.) in both mechanical engineering and nuclear engineering. Areas of study include biomechanics, control and adaptive systems, design and manufacturing, MEMS and nanotechnology, nuclear engineering, solid mechanics and materials, sustainable systems, and thermo-fluids. Program of study may include courses in other engineering disciplines as well as the sciences. A student enrolled in APOGEE (A Program of Graduate Engineering Education) may earn graduate credits and degrees while maintaining full-time employment. APOGEE students are governed by the same graduate policies and have the same access privileges to university resources as on-campus students.

M.E. degree requires a minimum of 30 credit hours of graded courses at 500-level or above, half of which must be 700-level. M.S. degree requires 6 hours of thesis credit and a minimum of 24 credit hours of graded courses at 500-level or above, half of which must be 700-level. M.E. and M.S. in mechanical engineering require a student to select one of 4 focus areas and take at least 3 courses from that area, and take 1 course each from other 3 areas. M.E. and M.S. in nuclear engineering require a student to take 3 required core courses, 1 math course from a list, and 4 elective courses from a list. Ph.D. degree students must complete 12 hours of dissertation credit. Those who have a master's degree in mechanical engineering or a closely related field must take 18 credit hours of graded courses at 500-level or above, half of which must be 700-level; those who do not have a master's degree must earn 48 graduate credit hours (42 or more hours must be graded courses at 500-level or above, half of which must be 700-level). All Ph.D. degree students are required to take a qualifying exam (with both oral and written parts) in the first Spring Semester after completing 3 graded graduate courses or at an earlier time. Ph.D. degree students must also take a comprehensive exam within 24 months (36 months for those enrolled in APOGEE) after entering the degree program and 12 months prior to graduation. This exam consists of a written dissertation proposal and an oral presentation and defense of the proposal.

Research Facilities

The research activities of the department are conducted in eight clusters of laboratories: (1) *South Carolina State Center for Mechanics of Materials and Non-Destructive Evaluation* (on-site) and nine laboratories for mechanical testing, experimental mechanics, materials characterization, computational mechanics, thermoplastics research, impact mechanics, advanced computer vision, and advanced joining; (2) *Thermo-Fluid Sciences Laboratories* with a wind tunnel for experimental fluid mechanics, heat transfer in material processing, applied heat transfer, and high-temperature and pressure research; (3) *Manufacturing and Design Laboratories* for CAD, friction stir welding, spot welding, machining, metrology, and metal casting facility; (4) *Sustainable Systems Laboratories* equipped with state of the art data processing and data mining systems; (5) *Laboratory of Adaptive Materials and Smart Structures (LAMSS)* for smart materials, adaptive systems, mechatronics, structural health monitoring, and active vibrations control; (6) *MEMS Laboratory* equipped with a new class 1000 clean-room for MEMS packaging and characterization; (7) *Nano-Structures and Reliability Laboratory* with nanoscale characterization equipment (e.g. nano-indenter and atomic force microscope); (8) *Biomechanics Laboratory* for multiaxial mechanical characterization and constitutive modeling of biomaterials. The department has a computational facility with Unix and Windows-based workstations and mechanical engineering software, such as FIDAP, NASTRAN, PATRAN, ABAQUS, ANSYS, and PRO-ENGINEER. The university has a well-equipped Electron Microscopy Center for materials characterization.

Financial Aid

Graduate teaching and research assistantships provide about $18,000/year for a full appointment (most graduate assistants receive full appointments). University fellowships are also available. Graduate students with assistantships only need to pay an in-state resident tuition (which is often covered by research grants).

Cost of Study

In 2005-06, tuition for 9 credit hours is $3,869 (resident) or $8,378 (non-resident) per spring or fall semester. Summer sessions are $384 per credit hour for residents and $816 per credit hour for nonresidents. Students also pay a fee every semester (in addition to a one-time enrollment fee of $500 for international students). Tuition and fees may change without notice.

Living and Housing Costs

2005-06 graduate housing monthly rates (including utilities) are $717 for a one-bed room apartment and $815-849 for a two-bed room apartment. Private rooms and apartments are also available near campus (which may cost less or more than university graduate housing).

Student Group

The department has a current graduate enrollment of 58 master's students and 43 Ph.D. students. About 36 percent of the students are from other countries.

Location

The University of South Carolina (USC) is located in Columbia, the state capital of South Carolina. Columbia is one of the fastest-growing metropolitan areas in the Southeast and currently has a metropolitan population of around 500,000. Columbia is served by several major airlines, major train and bus lines, and three interstate highways.

The University and the Department

USC was established in 1801. Its Columbia campus currently has more than 25,000 students. The College of Engineering and Information Technology celebrated its 100th anniversary in 1994. It currently offers Master's and doctoral degrees in five disciplines (chemical, civil/environmental, computer science/engineering, electrical, and mechanical/nuclear). The college has 1,295 undergraduate and 434 graduate students. Mechanical Engineering has 320 undergraduates, 101 graduate students, 21 full-time faculty members, 8 adjunct/research faculty members, and 6 staff members.

Applying

Applicants should have a B.S. and a GPA of 3.0/4.0 or better from an ABET accredited mechanical engineering program (if applying to graduate degree programs in mechanical engineering) or from any ABET accredited engineering program (if applying to graduate degree programs in nuclear engineering). Those not meeting the above conditions or who request assistantships and/or tuition support must take the general test of the Graduate Record Examinations and receive minimum scores of 450 verbal, 700 quantitative, and 500 analytical (or 3.5 analytical writing), and, if admitted, may be required to take certain undergraduate courses. Applicants whose native language is not English must take TOEFL and obtain a score of at least 600 on the paper based exam and 250 on the computer based exam, or take IELTS (academic course) and obtain a minimum score of 7.0. Two reference letters are required. Applications must be received by May 1 (July 1 for US applicants) for fall admission and Oct. 1 (Nov. 15 for US applicants) for spring admission. Application to the summer sessions is not considered unless a prior arrangement with the department is made.

Correspondence and Information

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THE FACULTY AND THEIR RESEARCH

Academic Faculty

Sarah C. Baxter, Associate Professor; Ph.D., Virginia, 1995. Micromechanics, characterizations of random heterogeneous materials, computational biomechanics.

Abdel E. Bayoumi, Professor; Ph.D., North Carolina State, 1982. Design, manufacturing, mechatronics, piezoelectric controlled electro-mechanical devices, and automation.

Jeffrey E. Bischoff, Assistant Professor; Ph.D., Michigan, 2001. Nonlinear constitutive modeling of biomaterials; artificial tissue development; growth and repair mechanisms; mechanical testing and characterization of soft tissue; computational biomechanics.

Bill Y.J. Chao, John Ducate, Sr. Professor; Ph.D., Illinois, Urbana-Champaign, 1981. Fracture mechanics, impact behavior of materials and structures, welding modeling, strength and failure testing and analysis, nanomechanics.

Jeff Darabi, Assistant Professor; Ph.D., University of Maryland, College Park, 1999. Microelectromechanical systems (MEMS), thermal system miniaturization using MEMS, microfluidic devices, BioMEMS, and novel fabrication techniques for MEMS devices and systems.

Xiaomin Deng, Professor; Ph.D., California Institute of Technology, 1990. Solid mechanics; computational mechanics; nanomechanics, molecular dynamics simulations; modeling and simulation of material behavior, 3-D mixed-mode crack growth and manufacturing processes.

Victor Giurgiutiu, Professor; Ph.D., Imperial College, London, UK, 1977. Active materials, smart structures, mechatronics, macro, micro, and nano-scale nondestructive evaluation, vibrations, structural health monitoring, diagnostics and prognostics, embedded microcontrollers.

Donald A. Keating, Associate Professor; B.M.E., M. Eng., Cornell University, 1958. Technology management of complex systems and engineering leadership issues in the development of organizations for technological innovation.

Jamil A. Khan, Professor and Interim Chair; Ph.D., Clemson, 1988. Heat transfer and fluids flow during manufacturing processes, phase change (solidification/melting in casting, welding), micro-channel heat transfer, convective transport, green manufacturing/re-manufacturing.

Travis W. Knight, Assistant Professor, Ph.D., University of Florida, 2000. Advanced nuclear fuels and materials, reactor design, advanced fuel cycles, space nuclear power and propulsion, and application of nuclear power in future energy economies for sustainability including the production of hydrogen from nuclear energy.

Xiaodong Li, Associate Professor; Ph.D., Harbin Institute of Technology, 1993. Nanofabrication, nanostructured materials/devices, reliability of nanostructures/devices, nanomechanical characterization.

Jed S. Lyons, Professor; Ph.D., Georgia Tech, 1990. Structure-processing-property relationships in engineering metals, polymers, ceramics and their composites, manufacturing methods and experimental techniques, engineering education research.

Stephen McNeill, Associate Professor; Ph.D., University of South Carolina, 1986. Experimental Mechanics, solid mechanics, reverse engineering.

Jeffrey Morehouse, Associate Professor; Ph.D., Auburn, 1976. Thermo-science applications including solar energy, modeling and system simulations, and automotive.

Walter H. Peters, Professor; Ph.D., Virginia Tech, 1978. Sustainable design, earth systems engineering, industrial ecology, environmental philosophy and ethics, complex systems analysis and design.

William F. Ranson, Professor; Ph.D., Illinois, 1971. Solid mechanics, applied mathematics applied to experimental methods, digital signal processing.

Anthony P. Reynolds, Associate Professor; Ph.D., Virginia, 1990. Metallurgy, fatigue and fracture, deformation mechanisms, friction stir welding, quantitative fractography.

Curtis A. Rhodes, Professor; Ph.D., Carnegie-Mellon, 1963. Computer-aided design and manufacturing, computational fluid mechanics.

David N. Rocheleau, Associate Professor; Ph.D., Florida, 1992. Engineering design, product development, applied mechanisms, robotics, mechatronics, and computer-aided design.

Michael A. Sutton, Carolina Distinguished Professor; Ph.D., Illinois, Champaign-Urbana, 1982. Solid mechanics, fracture mechanics, mixed mode fracture, experimental mechanics, multi-scale 2D and 3D digital image correlation, full-field strain measurement, residual stress, joining processes.

Philip Voglewede, Assistant Professor; Ph.D., Georgia Tech, 2004. Robotics, controls, mechanism design, theoretical kinematics, robotic locomotion, and parallel manipulators.

Adjunct/Research Faculty

Mel Buckner, Adjunct Professor; Ph.D., Nuclear Engineering, University of Tennessee, 1970. Plutonium disposition, advanced fuel cycle initiatives, and the SRS energy park including nuclear hydrogen production and university research reactor.

Maximilian Gorensek, Adjunct Professor; Ph.D., Chemical Engineering, Princeton University, 1981. Thermochemical hydrogen production process development, chemical flowsheet modeling of the high level waste treatment, chemical kinetics, fine particle separations, vinyl chloride production.

Yil Kim, Adjunct Professor; Ph.D., Mechanical Engineering, University of South Carolina, 2003. Finite element analysis of fracture mechanics problems, weld modeling, safety analysis for nuclear power plant components, and leak-before-break analysis for piping systems.

Valmore Loiselle, Adjunct Professor; M.S., Mechanical Engineering (Minor in Nuclear Engineering), Rensselaer Polytechnic Institute, 1973. Nuclear engineering; environmental remediation, emphasis on waste management and disposal; transportation and disposal of EPA pond closures, and metal recycle manufacturing.

Martin J. Pechersky, Adjunct Professor; Ph.D., Mechanical Engineering, Carnegie-Mellon University, 1972. Laser measurements and material processing, high power gas laser R&D, nuclear reactor thermal hydraulic testing and analysis, mathematical and computer modeling of physical systems.

Elwyn Roberts, Adjunct Professor; Ph.D., University of Sheffield, UK, 1960. Materials performance in nuclear reactors, product design, manufacturing and concurrent engineering.

Bill Summers, Adjunct Professor; Ph.D., Chemical Engineering, University of Pittsburgh, 1985. Nuclear engineering, fuel cells, nuclear hydrogen production

Balendra Sutharshan, Adjunct Professor; Ph.D., Massachusetts Institute of Technology, 1998. Thermal hydraulics and two-phase flows, reactor engineering, new product development, fuel reliability, fuel rod design, and application of lean and Six Sigma to Engineering and Manufacturing process.

Wei Zhao, Research Professor; Ph.D., Beijing Institute of Aeronautical Materials, 1989. Solid mechanics, structural integrity and reliability, probabilistic analysis and design, fatigue and fracture mechanics, computational mechanics, mechanical behaviors and microstructures of materials, wave propagation applied to structural health monitoring, forensic engineering.

AREAS OF CURRENT RESEARCH

Adaptive Materials and Smart Structures. Testing and characterization of piezoelectric and piezomagnetic active materials, induced-strain actuation with active materials, active sensors for structural health monitoring, damage detection and failure prevention, diagnostics and prognostics of machinery, structural morphing and active/adaptive vibration control.

Biomechanics. Nonlinear constitutive modeling of biomaterials; artificial tissue development; growth and repair mechanisms; mechanical testing and characterization of soft tissue; computational biomechanics.

Computational Mechanics. Three-dimensional mixed-mode crack growth simulation and computer code development; development of computational procedures for manufacturing and materials processing simulation; micro-mechanical/statistical characterization of material properties of random heterogeneous materials; simulation of material property fields associated with random composites; molecular dynamics simulations.

Computer-Aided Design. Three-dimensional geometric modeling, finite element modeling, reverse engineering, and product rapid prototyping using fused deposition modeling.

Engineering Education. Development and implementation of improved teaching methods in engineering; inquiry, project-based, problem-based and case-based methods; design of experiments, components and systems; assessment and evaluation of engineering education.

Experimental Mechanics. Testing and characterization of materials under various environmental conditions; impact testing at low, medium, and high strain rates; stable crack growth and fracture toughness testing; development of improved 2D and 3D digital image correlation methods and their applications at different length scales; testing and characterization of nano-structured materials and systems; residual stresses in welded joints.

Fluid Mechanics. CFD modeling with two-phase flow (mist eliminator); computational and experimental fluid dynamics related to contaminants transport in rooms; CFD modeling of industrial problems.

Heat/Mass Transfer. Heat and mass transfer with change of phase (welding, casting, metal matrix composites); experimental determination of thermo-physical properties; heat transfer in porous media; packed bed heat transfer; electronic cooling; micro-scale heat transfer in MEMS.

Manufacturing and Materials Processing. Mechanics of advanced manufacturing processes; jet assisted machining, ice-jet machining, laser machining; superplastic forming and formability; friction stir welding of Ti alloys, steel alloys, thick-section Al alloys, and Al-MMCs; measurement of torques and loads during FSW and implications on FSW process; resistance-spot welding.

Mechatronics. Electro-mechanical systems with embedded micro-controllers for sensing, actuation, and process control; piezoelectric controlled electro-mechanical devices; robots and autonomous vehicles; automotive systems by wire, camless engine, electric brake, and electric steering.

Microelectromechanical Systems (MEMS). Design, fabrication, characterization, packaging, simulation, and system-level integration of micro cooling systems, microfluidic devices, and BioMEMS..

Nanostructured Materials/Devices. Design, fabrication, reliability testing, and simulation of nanofilms and nanostructures; nanoscale material processing; nanomechanical characterization.

Nuclear Engineering. Production of radioisotopes in nuclear reactors and particle accelerators and medical applications of radioisotopes; microstructure-property-processing relationships in high performance/high temperature ceramics and nuclear fuels; advanced reactor design; nuclear space power and propulsion.

Solid Mechanics. Three-dimensional mixed-mode fracture criteria; material flow and residual stresses in friction stir welding; mechanics of metal cutting; mechanics of nano-structured materials and systems; welding modeling for distortion control; impact mechanics; weld mechanics.

Sustainable Systems. Sustainable valuation and decision-making methodologies, sustainable economic/industrial development and sustainable university services decision support; product-take-back modeling; sustainable construction practices; sustainable hotel management; sustainable systems practices at a military base; and complex system study and design.