MECHANICAL ENGINEERING

Department Website (https://sc.edu/study/colleges_schools/engineering_and_computing/departments/mechanical_engineering/)

Jamil A. Khan, *Chair*

The Department of Mechanical Engineering offers programs leading to the Master of Science, Master of Engineering, and Doctor of Philosophy degrees in both mechanical engineering and nuclear engineering. The department, jointly with the Department of Chemical Engineering, offers the Master of Science and Doctor of Philosophy degrees in biomedical engineering. Degree requirements for biomedical engineering are listed under the college offerings at Biomedical Engineering| .

Faculty fields of specialization include mechanics and materials, thermal and fluid sciences, dynamics and controls, design and manufacturing, sustainable systems, biomedical engineering, and nuclear engineering. Current research areas include manufacturing (cutting, joining, simulation), fracture mechanics, experimental mechanics (computer vision methods, impact/fracture/creep testing), computational mechanics, biomechanics, MEMS, nanosystems, smart materials and active sensing, structural damage detection and health monitoring, mechatronics, combustion, solidification, sustainable design, production 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.

Bachelor's/Master's Degrees Accelerated Program

The Bachelor's/Master's Degrees Accelerated Program in Mechanical Engineering allows undergraduate students to complete both the B.S.E. degree and M.E. or M.S. degree in as few as five years. The use of dual credit—courses that can be used toward both degrees—enables acceleration of the program, reducing the total enrollment of the student by one semester.

Mechanical engineering undergraduate students may apply for approval of an accelerated education plan in the semester in which they will complete 90 hours of undergraduate course work. In addition, students must have a sufficient foundation in mechanical engineering course work to enable them to take graduate-level courses. University and department regulations stipulate that applicants must have a minimum GPA of 3.40, both overall and in mechanical engineering courses. Students in the accelerated program must maintain a GPA of 3.40 while pursuing the B.S.E. degree.

Students applying to this program must submit to The Graduate School a completed "Accelerated Bachelor/Graduate Study Plan Authorization (G-ABGSP)" with endorsements of the undergraduate advisor, the department graduate director, and the department chair. The dean of The Graduate School has final authority for approving accelerated education plans. A "Senior Privilege Course Work Authorization" must be submitted for each semester in which one or more of these courses are taken.

Participation in the accelerated program does not require acceptance into The Graduate School. After completing the B.S.E. degree, students wishing to continue toward a master's degree in mechanical engineering at USC must apply formally to The Graduate School by submitting the appropriate form and required supporting documents. Students in the accelerated program will be eligible for graduate assistantships upon admission to The Graduate School.

Only graduate-level courses (numbered 500 and above, including up to three credit hours of project/research work leading to a master's thesis) satisfying both B.S.E. and master's degree requirements may be used for dual credit. No more than 12 credit hours may be used as dual credit.

Admissions

The Department of Mechanical Engineering offers six graduate degree programs: the Master of Science (M.S.) in mechanical engineering and in nuclear engineering, Master of Engineering (M.E.) in mechanical engineering and in nuclear engineering, and Doctor of Philosophy (Ph.D.) in mechanical engineering and in nuclear engineering. The Graduate School, based on recommendations from the department, grants admissions to these degree programs. All applications to the degree programs must be processed through the Graduate School office on the Columbia campus. Application information and forms can be obtained from the Graduate School's "Future Students" website at http://www.gradschool.sc.edu/futurestudents/index.html (http://www.gradschool.sc.edu/futurestudents/). Applications can be made online at the above website or by submitting the application forms to:

The Graduate School
University of South Carolina
Columbia, SC 29208, U.S.A.

USC admission standards are described in the Graduate Studies Bulletin. Specific admission requirements for graduate degree programs offered by DME are described below.

Admission Requirements

In general, the admission processes for the M.E., M.S., and Ph.D. programs in Mechanical Engineering and in Nuclear Engineering are highly competitive. Admission decisions are based on the quality of the applicant's previous university-level academic work (as reflected by grade point average or GPA), letters of recommendation, GRE scores, and other evidence of past accomplishments. GRE General Test scores must be submitted by all applicants seeking assistantships and/or tuition support and all applicants applying for a research based degree program (PhD or MS). A typical successful applicant has a GRE-Verbal score of at least 150 (450 prior scale) and GRE-Quantitative score of at least 155 (700 prior scale). Applicants applying for the Masters of Engineering program who graduate with a 3.0 or higher from an ABET accredited engineering program are not required to submit GRE scores.

International applicants must also submit internet based TOEFL (IBT) or IELTS International Academic Course Type 2 exam scores. An IBT minimum score of 80 or an IELTS score of 6.5 or better is required by the graduate school.

Programs

- Aerospace Engineering, M.E. (https://academicbulletins.sc.edu/graduate/engineering-computing/mechanical-engineering/aerospace-engineering-me/)
- Aerospace Engineering, M.S. (https://academicbulletins.sc.edu/graduate/engineering-computing/mechanical-engineering/aerospace-engineering-ms/)
- Mechanical Engineering, M.E. (https://academicbulletins.sc.edu/graduate/engineering-computing/mechanical-engineering/mechanical-engineering-me/)

- Mechanical Engineering, M.S. (https://academicbulletins.sc.edu/graduate/engineering-computing/mechanical-engineering/mechanical-engineering-ms/)
- Mechanical Engineering, Ph.D. (https://academicbulletins.sc.edu/graduate/engineering-computing/mechanical-engineering/mechanical-engineering-phd/)
- Nuclear Engineering, M.E. (https://academicbulletins.sc.edu/graduate/engineering-computing/mechanical-engineering/nuclear-engineering-me/)
- Nuclear Engineering, M.S. (https://academicbulletins.sc.edu/graduate/engineering-computing/mechanical-engineering/nuclear-engineering-ms/)
- Nuclear Engineering, Ph.D. (https://academicbulletins.sc.edu/graduate/engineering-computing/mechanical-engineering/nuclear-engineering-phd/)

Courses

EMCH 501 - Engineering Analysis I (3 Credits)
Engineering applications of solution techniques for ordinary and partial differential equations, including Sturm-Liouville theory, special functions, transform techniques, and numerical methods.
Prerequisites: MATH 242.

EMCH 502 - Engineering Analysis II (3 Credits)
Engineering applications of optimization methods, calculus of variations including approximate methods, and probability concepts.
Prerequisites: MATH 242.

EMCH 507 - Computer-Aided Design (3 Credits)
Solid modeling using commercial computer-aided design (CAD) applications package to reverse engineer-manufactured parts. Analytical curves and surfaces, transformation matrices, assembly modeling, and computer tools for analyzing parts and mechanisms.
Prerequisites: EMCH 201, EMCH 327.

EMCH 508 - Finite Element Analysis in Mechanical Engineering (3 Credits)
Development of the fundamental concepts of finite element modeling. Matrix equation assembly and reduction. Mechanical engineering applications in structures, stress analysis, ideal flow, and heat transfer problems.
Prerequisites: EMCH 201, EMCH 327.

EMCH 509 - Computer-Aided Manufacturing (3 Credits)
Optimizing computer-controlled machining processes, programmable logic controllers (PLCs), motion control of servomechanisms, CNC machining practices and programming, and robotics.
Prerequisites: D or better in MATH 241.

EMCH 516 - Control Theory in Mechanical Engineering (3 Credits)
An introduction to closed-loop control systems; development of concepts, including transfer function, feedback, frequency response, and system stability by examples taken from mechanical engineering practice; control system design methods.
Prerequisites: MATH 242, EMCH 330.

EMCH 520 - Technology Planning (3 Credits)
Assessment of technological needs in the organization; coupling research and development to production; selection and evaluation of the technical project/program; technical planning, resource allocation, direction, and control; effective use and development of the engineering staff; the process of and barriers to technological change; technology, values, and policy. Senior or graduate standing.

EMCH 521 - Concurrent Engineering (3 Credits)
A systematic approach to the mechanical design of products, requiring the concurrent design of all related processes.
Prerequisites: EMCH 327.

EMCH 522 - Design for Manufacture and Assembly (3 Credits)
Product design principles for early consideration of issues to shorten product development time and to ensure smooth transition to manufacturing, thus accelerating time-to-market.
Prerequisites: EMCH 327 and EMCH 377.

EMCH 527 - Design of Mechanical Systems (3 Credits)
Summary of mechanical design, project management, product liability and the law, intellectual property ethics and professionalism.
Prerequisites: EMCH 327.

EMCH 528 - Product Safety Engineering (3 Credits)
Design considerations and methodologies for products to ensure adequate safeguards for the prevention of accidents, failures, and injuries. Senior standing.

EMCH 529 - Sustainable Design and Development (3 Credits)
System design and development accomplished with consideration of environmental/ecological, economic, and social constraints. Students will be introduced to sustainable design and accomplish a design project. Senior standing.

EMCH 530 - Introduction to Engineering Optimization (3 Credits)
Mathematical formulation of an optimum design problem, introduction to optimum design concepts and multidisciplinary design optimization. Use of mathematical programming methods for unconstrained and constrained minimization for engineering design optimization.
Prerequisites: C or better in MATH 142, Graduate standing.

EMCH 532 - Intermediate Dynamics (3 Credits)
Kinematics and dynamics of particles and rigid bodies using Newtonian mechanics. Work/energy, impulse/momentum, 3-D motion.
Prerequisites: EMCH 332.

EMCH 535 - Robotics in Mechanical Engineering (3 Credits)
Overview of robotics in practice and research: forward and inverse kinematics, statics and dynamics, trajectory generation, control, vision, and motion planning.
Prerequisites: EMCH 332.

EMCH 544 - Compressible Fluid Flow (3 Credits)
Application of the conservation laws of a compressible fluid to isentropic flows, flow with friction, and flows with heating or cooling. Shock and expansion waves. Nozzle and diffuser design.
Prerequisites: EMCH 354.

EMCH 550 - Introduction to Nuclear Safeguards (3 Credits)
International nuclear non-proliferation programs and activities, proliferation risk assessment, and nuclear materials management and safeguards, including physical protection systems, material accounting and control, monitoring, and regulatory issues.
Prerequisites: CHEM 112, CHEM 112L, PHYS 212, PHYS 212L, MATH 241, MATH 242.

EMCH 551 - Nuclear Energy in the Hydrogen Economy (3 Credits)
The current role of nuclear energy in the US and global energy mix will be described and the potential for future growth will be surveyed, particularly in the development of the hydrogen economy.
Prerequisites: EMCH 354.

EMCH 552 - Introduction to Nuclear Engineering (3 Credits)
Radioactivity and nuclear reactions; steady state and transient nuclear reactor theory.

EMCH 553 - Nuclear Fuel Cycles (3 Credits)
Processing of nuclear fuel including fabrication, irradiation, and waste disposal or storage. In-core and out-of-core fuel management. Fuel cycle economics.
Prerequisites: EMCH 552.

EMCH 554 - Intermediate Heat Transfer (3 Credits)
Radiant heat exchange, combined modes of heat transfer, computer techniques in heat transfer analysis and design, environmental heat transfer.
Prerequisites: EMCH 354.

EMCH 555 - Instrumentation for Nuclear Engineering (3 Credits)
Basic operational principles of radiation detection and nuclear instrumentation systems. Selection of the proper detector to measure readiation. Statistical analysis of results.
Prerequisite or Corequisite: EMCH 552 or PHYS 511.

EMCH 555L - Nuclear Instrumentation Laboratory (1 Credit)
Use of nuclear radiation detection and instrumentation systems and computers. Data acquisition and analysis.
Corequisite: EMCH 555.

EMCH 556 - Introduction to Risk Analysis and Reactor Safety (3 Credits)
An introduction to probabilistic risk assessment (PRA) methods as applied to nuclear power plants but also examples from the chemical industry, aerospace, transportation, and other sectors. Addresses failure and reliability analysis, fault trees, event trees, reactor safety, regulatory practice.
Prerequisites: STAT 509.

EMCH 557 - Introduction to Radiation Shielding and Sources (3 Credits)
Radiation interactions and transport, design of radiation shields, point kernel, and Monte Carlo methods. Dosimetry, buildup factors, radiation sources, and shield materials.

EMCH 558 - Introduction to Nuclear Reactor Systems (3 Credits)
PWR and BWR reactors, reactor system designs for accident prevention and mitigation, protection systems, containment design, emergency cooling requirements, code of federal regulations, and design criteria.
Corequisite: EMCH 552.

EMCH 560 - Intermediate Fluid Mechanics (3 Credits)
Integral and differential analysis of fluids. Potential flow. Boundary layer analysis. Flow in closed and open channels. Flow dynamics of turbomachinery. Steady and unsteady flows.
Prerequisites: EMCH 310, EMCH 360.

EMCH 561 - Current Topics in Mechanical Engineering (1-3 Credits)
Special topics related to current issues in mechanical engineering. Course content varies and will be announced in the schedule of classes by title.

EMCH 562 - Micro/nanofluidics and Lab-on-a-Chip (3 Credits)
Basic fluid mechanics, capillary, drop and micro/nanoparticle, electrokinetics; micropump, mixer, preconcentrator, electrophoresis, microactuator and particle manipulator; sensors for pressure, velocity, concentration, temperature in environmental monitoring/biodefence, clinical diagnostics, drug discovery/delivery.
Prerequisites: D or better in CHEM 112 and CHEM112L or CHEM 142; D or better in PHYS 212.

Cross-listed course: BMEN 532

EMCH 567 - Bio Nano/Micro Electro-Mechanical Systems (3 Credits)
Fundamentals of nano- and microfabrication, metrology and their applications in biomedical engineering and science. The fabrication covers photolithography, nano/microfabrication for nano/microstructures, etching and additive techniques, MEMS integration and packaging, etc. Metrology focuses on characterization of nanostructures with imaging technologies.
Prerequisites: D or better in CHEM 112 and CHEM 112L or CHEM 142; D or better in PHYS 212.

Cross-listed course: BMEN 537

EMCH 571 - Mechanical Behavior of Materials (3 Credits)
Micromechanisms of the deformation and fracture of structural materials; brittle versus ductile behavior; fatigue and creep; strengthening mechanisms; mechanical testing techniques; methods in analysis of mechanical failures.
Prerequisites: EMCH 260, EMCH 371.

EMCH 572 - Physical Metallurgy (3 Credits)
Equilibrium and phase relations in metallic systems; kinetics of phase transformations; annealing and precipitation phenomena.
Prerequisites: EMCH 371.

EMCH 573 - Introduction to Nuclear Materials (3 Credits)
Materials for nuclear applications; materials degredation processes occuring in the nuclear reactor environment. Restricted to Engineering Upper Division and Graduate Students.

EMCH 575 - Adaptive Materials and Smart Structures (3 Credits)
A multidisciplinary introductory course addressing the engineering field of adaptive materials and smart structures.
Prerequisites: EMCH 260, EMCH 310.

EMCH 576 - Fundamentals and Applications of Fuel Cells (3 Credits)
Study of fuel cell principles, fuel cell characterization, characteristics of the major types of fuel cells, fuel cell and stack components, fuel cell stack and system design, fuel cell applications in portable, transportation, and stationary areas, as well as the current status and future research focus of fuel cells. Restricted to: Upper division.
Prerequisites: EMCH 290 or ECHE 310 or ENCP 290.

EMCH 577 - Aerospace Structures I (3 Credits)
Static analysis of aerospace structural elements such as bars, beams, columns, plates, and shells. Topics include, but not limited to elasticity theory, simple beam theory, boundary value problems, and structural stability. Upper division or graduate status.

EMCH 578 - Introduction to Aerodynamics (3 Credits)
Fundamentals of aerodynamics, elements of compressible flow, thin airfoil therory, finite wing theory, flow through nozzles diffusers and wind tunnels, normal and oblique shock waves, elements of the methods of characteristics of finite difference solutions for compressible flows, aspects of hypersonic flow.

EMCH 580 - Mechanics of Solid Biomaterials (3 Credits)
Introduction to the mechanical behavior of solid biomaterials. Structure and mechanical properties of tissue including skin, myocardium, and tendon. Mathematical treatment of anisotropic elasticity, nonlinear elasticity, linear and quasi-linear viscoelasticity, muscle activity.
Prerequisites: MATH 242.

EMCH 584 - Advanced Mechanics of Materials (3 Credits)
Topics in stress analysis, including unsymmetrical bending, three-dimensional stress-strain; torsion; rotational stress; thick-walled pressure vessels; beams on elastic foundations; and stress concentration.
Prerequisites: EMCH 260.

EMCH 585 - Introduction to Composite Materials (3 Credits)
Introduction to fiber reinforced polymer (FRP) composite materials, manufacturing methods and processes. Micro-Mechanics and properties of orthotropic laminated and woven composites. Analysis of composite structures (Mechanics and Synergistic environmental effects). Structure/property relationships. Characterization of modern composite materials. Design considerations.
Prerequisites: EMCH 327, EMCH 371, MATH 242.

EMCH 586 - Experimental Stress Analysis (3 Credits)
Stress analysis utilizing experimental techniques including transmission and scattered light photoelasticity, strain gauges, and brittle coatings. Introduction to modern concepts of coherent optics in stress analysis with emphasis on engineering applications.
Prerequisites: EMCH 260.

EMCH 592 - Introduction to Combustion (3 Credits)
Chemical thermodynamics, reaction kinetics, and combustion phenomena in energy production. Application to the modeling of coal combustion, incineration, and combustion engines.
Prerequisites: EMCH 354, EMCH 394.

EMCH 594 - Solar Heating (3 Credits)
Solar radiation; review of heat transfer and radiation characteristics of relevant materials; flat plate and focusing collectors; energy storage models for design of solar heating systems; system design by computer simulation; direct conversion by solar cells.
Prerequisites: EMCH 290, EMCH 354, or ECHE 321.

EMCH 597 - Thermal Environmental Engineering (3 Credits)
Vapor compression and absorption refrigeration systems. Heat pumps. Properties of refrigerants. Cryogenic refrigeration. Heating and cooling of buildings. Solar heating and cooling systems.
Prerequisites: EMCH 354, EMCH 394.

EMCH 701 - Methods of Engineering Analysis (3 Credits)
Variational methods of approximation are used with the finite element method to simulate the reliability predictions in design of mechanical systems. The functional relationship between geometry, materials, and physical laws of motion and energy are applied to solid, thermal, and fluid systems.
Prerequisites: EMCH 201.

EMCH 708 - Computer-Aided Product Design and Analysis (3 Credits)
Integration of computer-aided design and computer-aided engineering for shorter design cycles. Application of solid modeling and computer simulation tools to the design process.

EMCH 717 - Advanced Finite Element Methods (3 Credits)
Advanced finite element topics, including dynamic and nonlinear analyses. Computer projects will be assigned.
Prerequisites: EMCH 508.

EMCH 721 - Aeroelasticity (3 Credits)
Study the principles and applications of aircraft aeroelasticity with emphasis on aircraft structural dynamics, vibrations, unsteady aerodynamics, and interaction thereof.

EMCH 722 - Plasticity (3 Credits)
Basic experiments and observations of elastic-plastic material behavior; yield criteria; deformation and flow theories; slip line fields; numerical techniques; one and two dimensional applications.
Prerequisites: ENCP 707.

EMCH 727 - Advanced Mechanical Design (3 Credits)
Analysis of stresses involved in mechanical loading under various environmental conditions including failure criteria, impact and fatigue loading, residual stress, contact stress, and experimental stress analysis.
Prerequisites: EMCH 260.

EMCH 732 - Advanced Dynamics of Machinery (3 Credits)
Rigid body dynamics of mechanical systems. Dynamics of linkages, gears, and cams. Balancing. Synthesis of mechanisms. Digital computer and computer graphics methods in dynamics.
Prerequisites: EMCH 532

EMCH 741 - Viscous and Turbulent Flow (3 Credits)
Viscosity. The Navier-Stokes equation, its formulation and its properties. Exact solutions of the flow at low Reynolds number. Flow at high Reynolds number. The momentum theory of boundary layer. Turbulent flows.

EMCH 742 - Advanced Gas Dynamics (3 Credits)
Development of the general equations of frictionless flow. Small perturbation theory. Subsonic and supersonic similarity rules. Applications of the method of characteristics to unsteady flow. Low density flow fundamentals.

EMCH 743 - Aircraft and Rocket Propulsion (3 Credits)
Introduction to aircraft and rocket engines with emphasis on the performance and characteristics of various types of propulsion systems, including turbojet, turbofan, turboprop, ramjet, scramjet, and liquid and solid propellant rockets.
Prerequisite or Corequisite: EMCH 544.

EMCH 744 - Aerodynamics & Flight Mechanics (3 Credits)
Aerodynamics of wings and bodies in aircraft and the static and dynamic analysis of airplane flight mechanics. Topics include fundamentals of potential flows, thin airfoil theory, finite wing theory, laminar and turbulent boundary layers, trajectory analysis, and stability and control of an airplane.

EMCH 751 - Advanced Heat Transfer (3 Credits)
Development of the energy equation for convection and some exact solutions. Approximate analysis of the boundary layer by integral methods. Analogy between heat and momentum transfer. Experimental results.

EMCH 752 - Thermal Radiation Heat Transfer (3 Credits)
Radiation heat transfer between surfaces of enclosures; diffuse-gray and nondiffuse-gray surfaces. Radiative properties of real materials; metals, opaque nonmetals, transmitting solids. Gas radiation in enclosures.
Prerequisites: EMCH 751.

EMCH 753 - Chemical Thermodynamic Calculations and Modeling with Applications (3 Credits)
Principles of chemical thermodynamics; reactions, transformations, phase equilibria, and applications to engineering processes.

EMCH 754 - Thermal Hydraulic Design of Nuclear Reactors (3 Credits)
Power plant thermodynamics, reactor heat generation and removal (single-phase as well as two-phase coolant flow and heat transfer), and engineering considerations in reactor design.
Prerequisites: EMCH 552.

EMCH 755 - Advanced Nuclear Engineering (3 Credits)
Reactor physics including heterogeneous effects, multi-group calculations, reactor kinetics, stability and control, fuel depletion, and burnable poisons.
Prerequisites: EMCH 552.

EMCH 756 - Safety Analysis for Energy Systems (3 Credits)
Analysis of the safety of nuclear energy facilities focusing on reliability and probabilistic risk analysis.
Prerequisites: EMCH 552.

EMCH 757 - Radiation Shielding (3 Credits)
Radiation interactions and transport, design of radiation shields, point kernel, removal-diffusion, discrete ordinates, and Monte Carlo methods. Dosimetry, buildup factors, radiation sources, and shield materials.
Prerequisites: EMCH 552.

EMCH 758 - Nuclear Reactor Systems (3 Credits)
PWR and BWR reactors, reactor system designs for accident prevention and mitigation, protection systems, containment design, emergency cooling requirements, and atmospheric dispersion of radioactive material.
Prerequisites: EMCH 552.

EMCH 759 - Waste Management in the Nuclear Industry (3 Credits)
Management of low- and high-level radioactive, hazardous, and mixed waste; transportation, treatment, storage, and disposal techniques. Political and social issues involved with nuclear waste.
Prerequisites: EMCH 552.

EMCH 764 - Mechanical Engineering Projects (3 Credits)
Guided independent work on current research or design projects, culminating either in a written report or in the construction of a prototype device.

EMCH 767 - Microelectromechanical Systems (MEMS) (3 Credits)
Fundamentals of micromachining and microfabrication technologies, microsystem design, MEMS integration and packaging issues, design and analysis of microsensors and microactuators, microfluidics and bioMEMS, and CAD for MEMS. Design project required.

EMCH 770 - Predictive Modeling: Combining Experiments with Computations (3 Credits)
Experimental and computational uncertainties; combining experiments with computations to obtain "best - estimate" results with reduced uncertainties; predictive modeling.

EMCH 771 - Design Properties of Plastics (3 Credits)
Physical properties of various commercial thermoset and thermoplastic resins. Linear viscoelestic theory and its relationship to measurable mechanical properties of plastics.

EMCH 772 - Nuclear Materials (3 Credits)
This course focuses on behavior and performance of materials in nuclear irradiation fields. Materials used in the core for reactivity control and materials used for structural support will be studied.

EMCH 774 - Radiation Damage (3 Credits)
Structural materials for nuclear application; Radiation interaction with matter; Microstructure evolution under irradiation; Material properties degradation under irradation.
Prerequisites: EMCH 573.

EMCH 777 - Aerospace Structures II (3 Credits)
Principles and applications of aerospace structures with emphasis on the construction and analysis of thin-wall monocoque and semi-monocoque wings and fuselages.
Prerequisite or Corequisite: EMCH 577.

EMCH 778 - Nanomaterials: Synthesis, Characterization, and Applications (3 Credits)
Advances in nanomaterials; synthesis of nanomaterials; nanoparticles, nanotubes/wires, nanometer thick thin films, nanostructured bulk materials; assembly of nanostructures; biologically inspired structures; structure-property-correlations in nanomaterials and nanostructures; advanced characterization techniques; applications, especially those related to nanotechnology, information technology, MEMS/NEMS, and biotechnology.
Prerequisites: EMCH 371.

EMCH 780 - Energy Storage (3 Credits)
This course is aimed to provide graduate students with a comprehensive introduction to the various energy storage mechanisms and technologies that are currently being utilized. The content of the course includes methods and mechanisms of common energy storage (thermal, mechanical, chemical and electrochemical).

EMCH 785 - Design of Composite Materials for Aerospace Structures (3 Credits)
Property and performance requirements for aerospace structures. Design for stiffness, strength, durability, damage tolerance, and life at the lamina, laminate, and structural level (materials and analysis).

EMCH 790 - Mechanical Engineering for Teachers I (3 Credits)
Introduction to concepts of modeling, dimensional analysis, lift, and drag. For preservice teachers enrolled in a professional program (M.A.T. and M.T. students) and in-service teachers (M.Ed. and Ed.S. students) only.

EMCH 791 - Selected Topics in Thermal Systems (1-3 Credits)
Special topics related to current research in thermal systems.

EMCH 792 - Selected Topics in Mechanical Systems (1-3 Credits)
Special topics related to current research in mechanical systems.

EMCH 793 - Combustion Processes in Industry (3 Credits)
Development of the physics of turbulent flow, turbulent combustion, atomization, and vaporization of liquid sprays. Design and analysis of industrial combustion processes including incinerators and furnaces.
Prerequisites: EMCH 592.

EMCH 794 - Thermodynamics (3 Credits)
An advanced treatment of thermodynamics stressing fundamentals. Application of first and second laws; study of properties and criteria for reactive, non-reactive, and coupled systems.
Prerequisites: EMCH 354 and EMCH 394.

EMCH 799 - Thesis Preparation (1-12 Credits)

EMCH 847 - Fluid Systems Design (3 Credits)
Hydrodynamics of one and two-phase flow in ducts. Pressure surges and flow stability. Flow induced vibrations. Numerical techniques. Fluid power systems design.
Prerequisites: EMCH 741.

EMCH 857 - Advanced Heat Transfer II (3 Credits)
Solution of radiation problems through non-absorbing, non-emitting media. Heat exchanger design.

EMCH 881 - Fatigue of Materials (3 Credits)
Fatigue of materials presented from mechanics and microstructural points of view. Stress-life, strain life, and Linear Elastic Fracture Mechanics (LEFM) approaches will be covered.

EMCH 882 - Fracture Mechanics (3 Credits)
Linear elastic and elastoplastic description of stress fields around cracks. Discussion of stress intensity factor, strain energy density. Dynamic crack propagation and arrest. Fatigue crack propagation. Fracture toughness testing. Applications of concepts.
Prerequisites: EMCH 584.

EMCH 883 - Wave Propagation in Solids (3 Credits)
Formulation and solution of the wave propagation problem in an unbounded isotropic medium. Study of the reflection-refraction problem at a plane interface. Discussion of Rayleigh, Love, and general surface waves. Wave propagation in a bounded isotropic medium.
Prerequisites: ENCP 707.

EMCH 899 - Dissertation Preparation (1-12 Credits)