

# MECHANICAL ENGINEERING (ME)

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## **ME 6007. Interfacial Fluid Mechanics. 3 Credit Hours.**

The mechanics of fluid interfaces. Mathematical techniques of scaling and calculus of curved surfaces towards analysis of menisci, bubbles, jets, films, foams, and coatings.

## **ME 6101. Engineering Design. 3 Credit Hours.**

Design concepts, processes, and methodologies, including quality and robustness. Group project.

## **ME 6102. Designing Open Engineering Systems. 3 Credit Hours.**

Decision-based integrated product and process development, meta-design, and decision support problems; mathematical modeling of decisions involving ambiguity and uncertainty; critical thinking and analysis; verification and validation; research issues.

## **ME 6103. Optimization in Engineering Design. 3 Credit Hours.**

Use of single and multi-objective optimization in modeling and solving mechanical engineering design problems. Formulations, solution algorithms, validation and verification, computer implementation. Project.

## **ME 6104. Computer-Aided Design. 3 Credit Hours.**

Fundamentals of CAD, including geometric and solid modeling, parametric representations, features, and human-machine interactions. Applications to design, analysis, and manufacturing.

## **ME 6105. Modeling and Simulation in Design. 3 Credit Hours.**

Modeling and simulation concepts, algorithms, and methods; modeling of energy-based and discrete-event systems; modeling of design decisions; information modeling and knowledge representation; project.

## **ME 6124. Finite-Element Method: Theory and Practice. 3 Credit Hours.**

Line, plane, solid, plate, and shell elements-theory: practical aspects of modeling; applications in mechanical engineering; final project.

## **ME 6201. Principles of Continuum Mechanics. 3 Credit Hours.**

Introductory treatment of the fundamental, unifying concepts of the mechanics of continua.

## **ME 6203. Inelastic Deformation of Solids. 3 Credit Hours.**

Phenomenological aspects of nonlinear material behavior and deformation with emphasis on model development.

## **ME 6204. Micromechanics of Materials. 3 Credit Hours.**

Fundamental concepts of micromechanics of solids with emphasis on application to composite materials.

## **ME 6222. Manufacturing Processes and Systems. 3 Credit Hours.**

Materials processing analysis and selection. Manufacturing systems design. Economic analysis.

## **ME 6223. Automated Manufacturing Process Planning. 3 Credit Hours.**

Fundamentals of process planning. Automated process planning approaches and algorithms. Geometric modeling for process planning. Modeling and analysis of flexible fixturing systems. Mechanical assembly planning.

## **ME 6224. Machine Tool Analysis and Control. 3 Credit Hours.**

Mechanics and dynamics of machining, machine tool components and structures, sensors and control of machine tools, machine process planning and optimization.

## **ME 6225. Metrology and Measurement Systems. 3 Credit Hours.**

Metrology techniques and procedures. Precision manufacturing system design and analysis.

## **ME 6229. Introduction to Micro-Electro-Mechanical Systems. 3 Credit Hours.**

Principles of microfabrication for sensors and actuators. Lumped parameter analysis and computer-aided design; materials properties; case studies include cantilever beam, pressure sensor, and accelerometer.

## **ME 6242. Mechanics of Contact. 3 Credit Hours.**

Mechanics of surface contact, with emphasis on tribological interactions as in rolling element bearings, slider bearings, mechanical seals, and materials processing.

## **ME 6243. Fluid Film Lubrication. 3 Credit Hours.**

Analytical and numerical investigation of full film compressible and incompressible hydrodynamic lubrication problems for steady and unsteady conditions.

## **ME 6244. Rotordynamics. 3 Credit Hours.**

Analysis and design of shafts for rotating machinery. Torsional vibration, synchronous and nonsynchronous whirl, stability, gyroscopic effects, hydrodynamic bearings, hysteresis, squeeze film dampers, and balancing.

## **ME 6281. Mechanics of Paper Forming and Coating. 3 Credit Hours.**

Fundamentals of multiphase flow in paper forming and coating processes, and its impact on the physical properties of composite fiber structure and surface characteristics.

## **ME 6300. Intermediate Heat Transfer. 3 Credit Hours.**

Intermediate topics including multidimensional transient conduction, diffusion, boundary layers, internal flows, radiation, phase change, heat exchangers, multimode transfer, and numerical methods with a project-oriented approach.

## **ME 6301. Conduction Heat Transfer. 3 Credit Hours.**

Steady and transient one- and multi-dimensional conduction. Emphasis on analytical methods, numerical techniques, and approximate solutions.

## **ME 6302. Convection Heat Transfer. 3 Credit Hours.**

Convection (forced and free) in laminar and turbulent, internal and external flows. Analogy between momentum and heat transfer. Scaling laws and modeling.

## **ME 6303. Thermal Radiation Heat Transfer. 3 Credit Hours.**

Fundamentals of thermal radiation, blackbody radiation, surface characteristics, exchange in enclosures, radiation through continua, and combined mode heat transfer.

## **ME 6304. Principles of Thermodynamics. 3 Credit Hours.**

Fundamentals of thermodynamics including energy, entropy, and energy analysis, property relations, equilibrium conditions, and evaluation of properties.

## **ME 6305. Applications of Thermodynamics. 3 Credit Hours.**

Applications of the first and second laws of thermodynamics to analysis and design optimization of power and refrigeration systems incorporating heat exchangers and combustion processes.

## **ME 6309. Nanoscale Heat Transfer. 3 Credit Hours.**

Microscopic concepts and methodology in thermal science, including equilibrium statistics. Boltzmann transport equation, and nano-microscale heat conduction and radiation, with applications in contemporary technologies.

## **ME 6335. NUMERICAL HEAT TRANSFER. 3 Credit Hours.**

This course will provide foundation to develop numerical solutions for steady state and transient thermal transport problems in complex geometries.

**ME 6401. Linear Control Systems. 3 Credit Hours.**

Theory and applications of linear systems, state space, stability, feedback controls, observers, LQR, LQG, Kalman filters. Credit will not be awarded for both ME 6401 and AE 6530.

**ME 6402. Nonlinear Control Systems. 3 Credit Hours.**

Analysis of nonlinear systems, geometric control, variable structure control, adaptive control, optimal control, applications.

**ME 6403. Digital Control Systems. 3 Credit Hours.**

Comprehensive treatment of the representation, analysis, and design of discrete-time systems. Techniques include Z- and W- transforms, direct method, control design, and digital tracking.

**ME 6404. Advanced Control System Design and Implementation. 3 Credit Hours.**

Analysis, synthesis, and implementation techniques of continuous-time and real-time control systems using classical and state-space methods.

**ME 6405. Introduction to Mechatronics. 3 Credit Hours.**

Modeling and control of actuators and electro-mechanical systems. Performance and application of microprocessors and analog electronics to modern mechatronic systems.

**ME 6406. Machine Vision. 3 Credit Hours.**

Design of algorithms for vision systems for manufacturing, farming, construction, and the service industries. Image processing, optics, illumination, feature representation.

**ME 6407. Robotics. 3 Credit Hours.**

Analysis and design of robotic systems including arms and vehicles. Kinematics and dynamics. Algorithms for describing, planning, commanding, and controlling motion force.

**ME 6408. Advanced Mechatronics. 3 Credit Hours.**

Focusing on team projects, designing and building intelligent machines and products. Lectures - sensors and transducers, actuators, fluid power, power rectifiers, motion control and modeling of mechatronics systems.

**ME 6441. Dynamics of Mechanical Systems. 3 Credit Hours.**

Motion analysis and dynamics modeling of systems of particles and rigid bodies in three-dimensional motion.

**ME 6442. Vibration of Mechanical Systems. 3 Credit Hours.**

Introduction to modeling and oscillatory response analysis for discrete continuous mechanical and structural systems.

**ME 6443. Variational Methods in Engineering. 3 Credit Hours.**

Calculus of variations, Hamilton's principle and Lagrange's equations, Sturm-Liouville problems, approximation techniques.

**ME 6444. Nonlinear Systems. 3 Credit Hours.**

Investigation of nonlinear systems using analytical and numerical techniques.

**ME 6449. Acoustic Transducers and Signal Analysis. 3 Credit Hours.**

Acoustic instrumentation and methods of signal analysis.

**ME 6452. Wave Propagation in Solids. 3 Credit Hours.**

Wave motion in solids, wave equations, analytical and numerical solutions, ultrasonic NDE.

**ME 6460. Microelectromechanical Devices. 3 Credit Hours.**

Introduces fundamental concepts and tools needed for the design, simulation and analysis of MEMS devices. These include electrical, mechanical, radiant, thermal, magnetic and chemical domains.

**ME 6601. Introduction to Fluid Mechanics. 3 Credit Hours.**

The fundamentals of fluid mechanics. Derivation of the governing equations of motion. An introduction to viscous, inviscid, turbulent, and boundary-layer flows.

**ME 6602. Viscous Flow. 3 Credit Hours.**

The mechanics of Newtonian viscous fluids. The use of modern analytical techniques to obtain solutions for flows with small and large Reynolds numbers.

**ME 6607. Interfacial Fluid Mechanics. 3 Credit Hours.**

The mechanics of fluid interfaces. Mathematical techniques of scaling and calculus of curved surfaces towards analysis of menisci, bubbles, jets, films, foams, and coatings.

**ME 6622. Experimental Methods. 3 Credit Hours.**

Experimental methods in mechanics. Includes measurement techniques, instrumentation, data acquisition, signal processing, and linear and digital electronics.

**ME 6701. Wind Engineering. 3 Credit Hours.**

An introductory course on wind energy and its potential; modeling and design of wind turbines; analysis of the economic benefits of wind turbine systems. Credit will not be awarded for both ME 6701 and AE 6701.

**ME 6705. Introduction to Mechatronics. 4 Credit Hours.**

Modeling and control of actuators and electro-mechanical systems. Performance and application of microprocessors and analog electronics to modern mechatronic systems.

**ME 6720. Biotransport. 3 Credit Hours.**

This graduate level course covers the analysis of fluid flow phenomena in the human body, cardiovascular, respiratory system and other organ systems. Credit will not be awarded for both ME 6720 and BMED 6720.

**ME 6741. Pulp and Paper Manufacture I. 3 Credit Hours.**

The fundamentals of pulp and paper technology are presented. Applications to the several unit operations used are explored and augmented by field trips and recent case studies. Crosslisted with CHE 6741, CHBE 6701 and MLDR 6701.

**ME 6743. Tissue Mechanics. 3 Credit Hours.**

Structure-function relationships and constitutive models for a variety of biological tissues, with an emphasis on understanding the mechanical behaviors of normal and pathological tissues. Credit not give for both ME/BMED 6783 and ME/BMED 6743. Crosslisted with BMED 6743.

**ME 6744. Topics in Engineering Practice. 3 Credit Hours.**

Topics of current importance offered in collaboration with an approved partner of Georgia Tech's Distance Learning Program. Crosslisted with ECE 6744.

**ME 6746. Rehabilitation Engineering. 3 Credit Hours.**

Students will participate in rehabilitation engineering as practiced in the assistive technology industry. Credit not allowed for both ME 6746 and APPH 6746.

**ME 6753. Principles of Management for Engineers. 3 Credit Hours.**

The course will provide an introduction to selected topics needed to be successful in the technology industries. Cannot count toward major area requirements on M.S. or Ph.D. programs of study. Crosslisted with MGT 6753.

**ME 6760. Acoustics I and II. 3 Credit Hours.**

Fundamental principles governing the generation, propagation, reflection, and transmission of sound waves in fluids. Crosslisted with AE 6760.

**ME 6761. Acoustics I and II. 3 Credit Hours.**

Radiation and scattering of sound waves in fluids, duct acoustics, dissipation phenomena. Crosslisted with AE 6761.

**ME 6762. Applied Acoustics. 3 Credit Hours.**

Mufflers, resonators, acoustic materials, barriers, industrial noise, room acoustics, active noise control. Crosslisted with AE 6762.

**ME 6765. Kinetics and Thermodynamics of Gases. 4 Credit Hours.**

Thermodynamics of nonreacting and reacting gas mixtures. Introductory quantum theory, statistical thermodynamics, and gas kinetic theory. Crosslisted with AE 6765.

**ME 6766. Combustion I. 3 Credit Hours.**

Introductory chemical kinetics, deformations and deflagrations, laminar flame propagation in premixed gases, ignition and quenching, laminar diffusion flames, droplet burning, and turbulent reacting flows. Crosslisted with AE 6766.

**ME 6768. Polymer Structure, Physical Properties, and Characterization. 3 Credit Hours.**

Formulations and analysis of molecular and phenomenological models of elastic and viscoelastic behavior, development and description of structure, and fundamental aspects of structure-property relations. Crosslisted with CHE, MSE, and PTFE 6768.

**ME 6769. Linear Elasticity. 3 Credit Hours.**

Governing equations of linear elasticity, plane elasticity, boundary-value problems, airy stress function and complex variable methods, simple three-dimensional solutions. Crosslisted with AE 6769.

**ME 6770. Energy and Variational Methods in Elasticity and Plasticity. 3 Credit Hours.**

Applications in energy and variational methods in engineering mechanics to elastic, plastic, and dynamical behavior of deformable media. Crosslisted with AE 6770.

**ME 6776. Integrated Low-cost Microelectronics Systems Packaging. 3 Credit Hours.**

Broad overview of system-level, cross-disciplinary microelectronics packaging technologies, including design, test, thermal, reliability, optoelectronics, and RF integration. Comparison of system-on-chip and system-on-package. Crosslisted with ECE and MSE 6776.

**ME 6777. Advanced Biomaterials. 3 Credit Hours.**

Advanced topics of biomaterials performance and engineering, including biointerfaces, host reactions to materials, and bio-inspired/smart-materials strategies. Crosslisted with BMED, CHE, and MSE 6777.

**ME 6779. Thermal Engineering for Packaging of Micro and Nano Systems. 3 Credit Hours.**

Passive, active, and hybrid thermal management techniques, and computational modeling of micro systems. Air cooling, single phase and phase change liquid cooling, heat pipes, and thermoelectrics. Crosslisted with ECE 6779.

**ME 6782. Cellular Engineering. 3 Credit Hours.**

Engineering analysis of cellular systems. Crosslisted with BMED and CHE 6782.

**ME 6789. Technology Ventures. 3 Credit Hours.**

Team discussion and case studies of issues in biomedical engineering technology transfer including licensing, financial capital, safety and efficacy studies, clinical trials, and strategic planning. Crosslisted with BMED, ECE, CHE, and MGT 6789.

**ME 6792. Computer Integrated Manufacturing Systems Seminar. 1 Credit Hour.**

Guest speakers on a broad range of manufacturing-related topics: research, applications, and technology. Required for Certificate in Manufacturing. Crosslisted with ECE and ISYE 6792.

**ME 6793. Systems Pathophysiology. 3 Credit Hours.**

Overview of human pathophysiology from a quantitative perspective. Emphasis on systems of interest to bioengineering faculty. Introduction to quantitative models for biological systems. Crosslisted with BMED, CHE, and ECE 6793.

**ME 6794. Tissue Engineering. 3 Credit Hours.**

Biological, engineering, and medical issues in developing tissue-engineered constructs. Emphasis in the integration of these disciplines at a basic molecular and cell biology level. Crosslisted with BMED and CHE 6794.

**ME 6795. Mathematical, Statistical, and Computational Techniques in Materials Science. 3 Credit Hours.**

Emphasizes the fundamental physical, analytical, and mathematical techniques commonly encountered in materials engineering including stress and strain, crystallographic and orientation transformations, X-ray, TEM, and solid-state concepts. Crosslisted with MSE and PTFE 6795.

**ME 6796. Structure-Property Relationships in Materials. 3 Credit Hours.**

Introduction to the multi-scale structure effects on material properties. For MSE students, this course will prepare students for future in-depth courses. For non-MSE students, the course will provide a background in materials and may serve as part of the program of study for a minor in materials. Crosslisted with MSE and PTFE 6796.

**ME 6797. Thermodynamics and Kinetics of Microstructural Evolution. 3 Credit Hours.**

The reduction of chemical-free energy, strain energy, and interfacial energy controls the kinetics of diffusional transformations. These factors are explored from the point of view of processing and stability of the microstructure during service. Crosslisted with MSE and PTFE 6797.

**ME 6799. Legal Issues in Technology Transfer. 3 Credit Hours.**

Study and analysis of U.S. law as it applies to the patenting and licensing processes. Crosslisted with CHE, MGT, and BMED 6799.

**ME 6XXX. Mechanical Engineering Elective. 1-21 Credit Hours.****ME 7000. Master's Thesis. 1-21 Credit Hours.****ME 7056. GT-STUTTGART. 12 Credit Hours.**

Placeholder for GT-STUTTGART students.

**ME 7057. GT-SEOUL. 12 Credit Hours.**

Placeholder for GT-SEOUL students.

**ME 7201. Computational Mechanics of Materials. 3 Credit Hours.**

Computational treatments of material and geometric nonlinearity, with emphasis on rate-dependent elasto-plasticity and fracture.

**ME 7203. Advanced Constitutive Relations for Solids. 3 Credit Hours.**

Advanced treatment of constitutive laws for nonlinear behavior of solids. Coupled thermomechanical laws and underlying physical and thermodynamical bases. Behavior of media with underlying substructure.

**ME 7205. Mechanics and Applications of Nanostructured Materials and Devices. 3 Credit Hours.**

Introduction to mechanics and transport processes of discrete atomistic and molecular systems, fabrication of nanodevices/structures and applications to nanoelectronics, tribology, actuation and sensors.

**ME 7227. Rapid Prototyping in Engineering. 3 Credit Hours.**

Rapid prototyping technologies in engineering design. Physical principles, materials, materials processing. Laboratory demonstrations and project.

**ME 7301. Transport Phenomena in Multiphase Flow. 3 Credit Hours.**

Gas-liquid, two-phase flow patterns, basic and empirical models; conservation equations and closure relations; pool and convective boiling; aerosol transport; condensation.

**ME 7442. Vibration of Continuous Systems. 3 Credit Hours.**

Equations of motion and oscillatory response of dynamic systems modeled as continuous media.

**ME 7602. Hydrodynamic Stability. 3 Credit Hours.**

Hydrodynamic stability of fluid flows using linear, energy, and nonlinear stability theories. Taylor-Couette, buoyancy-driven, surface-tension-driven, shear, and thin-film flows.

**ME 7741. Robotics Professional Preparation. 1 Credit Hour.**

Preparation for a professional career in Robotics. Local & visiting speakers. Program introduction. Technical resume preparation. GT Robotics labs & resources.

**ME 7742. Robotics Professional Preparation 2. 1 Credit Hour.**

Preparation for a professional career in Robotics. Local & visiting speakers. Selecting and applying for Internship. Developing capstone project proposal. Public speaking practice and preparation.

**ME 7743. Robotics Professional Preparation 3. 1 Credit Hour.**

Preparation for a professional career in Robotics. Local & visiting speakers. Interview preparation & career search. Technical report writing and presentation.

**ME 7751. Computational Fluid Mechanics. 3 Credit Hours.**

Numerical methods for solving the time-dependent Navier-Stokes equations in complex geometrics, including theory, implementation, and applications. Crosslisted with CEE 7751.

**ME 7757. Teaching Practicum. 3 Credit Hours.**

Supervised teaching for doctoral students. Teaching techniques, course and curriculum design, student evaluation methods and criteria. Students may, in some instances, prepare and present lectures. Crosslisted with NRE, HP, and CHBE 7757.

**ME 7764. Acoustic Propagation. 3 Credit Hours.**

Propagation of sound in inhomogeneous fluids; ray acoustics, ocean and atmospheric acoustics, nonlinear acoustics. Crosslisted with AE 7764.

**ME 7771. Mechanics of Polymer Solids and Fluids. 3 Credit Hours.**

Continuum mechanics of solids and fluids; mechanics of deformation of anisotropic polymers; yield, breaking, and fatigue; non-Newtonian viscous and viscoelastic behavior of polymer fluids. Crosslisted with CHE, MSE, and PTFE 7771.

**ME 7772. Fundamentals of Fracture Mechanics. 3 Credit Hours.**

Advanced study of failure of structural materials under load, mechanics of fracture, and microscopic and macroscopic aspects of the fracture of engineering materials. Crosslisted with AE, CEE, CHE, and MSE 7772.

**ME 7773. Advanced Fracture Mechanics. 3 Credit Hours.**

Nonlinear fracture mechanics including elastic-plastic and time-dependent fracture, advanced test methods, J-integral theory, and extensions. Crosslisted with AE, CEE, CHE, and MSE 7773.

**ME 7774. Fatigue of Materials and Structures. 3 Credit Hours.**

Mechanical and microstructural aspects of nucleation and growth of cracks under cyclic loading conditions, notch effects, cumulative damage, multiaxial loading, and fatigue crack propagation. Crosslisted with AE, CEE, CHE, and MSE 7774.

**ME 7775. Topics in Fracture and Fatigue of Metallic and Composite Structures. 3 Credit Hours.**

Brittle and ductile failure criteria. Failure prediction in composite structures. Free-edge and internal delamination. Anisotropic cracks. Fatigue behavior of composites and comparison with metal fatigue. Crosslisted with AE, CHE, and MSE 7775.

**ME 7785. Introduction to Robotics Research. 3 Credit Hours.**

Familiarizes students with the core areas of robotics; mechanics, control, perception, AI, and autonomy. Provides an introduction to the mathematical tools required in robotics research.

**ME 7793. Manufacturing of Composites. 3 Credit Hours.**

Major manufacturing techniques of metal-ceramic and polymer-matrix composites. Modeling of processes with emphasis on fundamental mechanisms and effects. Crosslisted with AE, CEE, CHE, MSE, and PTFE 7793.

**ME 8001. Master Seminar I. 1 Credit Hour.**

Seminars for MSME students. Credit not allowed for both ME 8001 and ECE 8001.

**ME 8002. Master Seminar II. 1 Credit Hour.**

Seminars for MSME students. Credit not allowed for both ME 8002 and ECE 8001.

**ME 8010. Seminars in Mechanical Engineering. 1 Credit Hour.**

Seminars involving current research projects presented by graduate students, faculty, and invited speakers.

**ME 8011. Seminars in Mechanical Engineering. 1 Credit Hour.**

Seminars involving current research projects presented by graduate students, faculty, and invited speakers.

**ME 8012. Seminars in Mechanical Engineering. 1 Credit Hour.**

Seminars involving current research projects presented by graduate students, faculty, and invited speakers.

**ME 8014. Seminars in Mechanical Engineering. 2 Credit Hours.**

Seminars involving current research projects presented by graduate students, faculty, and invited speakers.

**ME 8740. Robotics Internship. 1-21 Credit Hours.**

Graduate Internship at a partner company, GTRI or a GT Robotics lab.

**ME 8741. Robotics Capstone Project. 3 Credit Hours.**

Teams or individuals apply the knowledge and skills acquired throughout the MS program to a faculty supervised robotics project.

**ME 8750. Robotics Research Foundation I. 3 Credit Hours.**

Multidisciplinary research course supervised by two robotics faculty from different schools participating in the robotics Ph.D. program.

**ME 8751. Robotics Research Foundation II. 3 Credit Hours.**

Continuation of ME 8751 (Robotics Research Foundation I).

**ME 8801. Special Topics in Manufacturing. 1 Credit Hour.**

Special topic offerings of current interest in manufacturing not included in regular courses.

**ME 8802. Special Topics in Manufacturing. 2 Credit Hours.**

Special topic offerings of current interest in manufacturing not included in regular courses.

**ME 8803. Special Topics in Manufacturing. 3 Credit Hours.**

Special topic offerings of current interest in manufacturing not included in regular courses.

**ME 8804. Special Topics in Manufacturing. 4 Credit Hours.**

Special topic offerings of current interest in manufacturing not included in regular courses.

**ME 8805. Special Topics in Manufacturing. 5 Credit Hours.**

Special topic offerings of current interest in manufacturing not included in regular courses.

**ME 8806. Special Topics in Manufacturing. 6 Credit Hours.**

Special topic offerings of current interest in manufacturing not included in regular courses.







**ME 8983. Special Problems in Mechanics of Materials. 1-21 Credit Hours.**

Individual studies and/or experimental investigations of problems of current interest in mechanics of materials.

**ME 8984. Special Problems in Mechanics of Materials. 1-21 Credit Hours.**

Individual studies and/or experimental investigations of problems of current interest in the mechanics of materials.

**ME 8985. Special Problems in Mechanics of Materials. 1-21 Credit Hours.**

Individual studies and/or experimental investigations of problems of current interest in the mechanics of materials.

**ME 8986. Special Problems in Mechanics of Materials. 1-21 Credit Hours.**

Individual studies and/or experimental investigations of problems of current interest in the mechanics of materials.

**ME 8997. Teaching Assistantship. 1-9 Credit Hours.**

For graduate students holding graduate teaching assistantships.

**ME 8998. Research Assistantship. 1-9 Credit Hours.**

For graduate students holding graduate research assistantships.

**ME 9000. Doctoral Thesis. 1-21 Credit Hours.**