

M.S. in Mechanical Engineering

Candidates must satisfy a total of 30 credit hours (CH) with a minimum G.P.A. of 3.000 on a 4.000 scale.

All students must complete 30 credit hours (CH) from graduate-level courses or 24 credit hours and a thesis.

Design and Dynamic Systems and Controls

ME 7302 Linear System Analysis (core)

The course will introduce students to the topics within the domain of modern control theory. Special emphasis will be placed on the application of the developed concepts in designing linear systems and casting their responses in prescribed forms. Topics covered are state representation of linear systems, controllability, observability, and minimal representation, linear state variable feedback, observers and quadratic regulator theory.

Prerequisite: ME 4360/EE 3370 or permission of the instructor.

ME 7320 Intermediate Dynamics (core)

Kinematics and dynamics of particles and rigid bodies: kinematics, inertia properties, momentum and energy principles, generalized forces, holonomic and nonholonomic constraints, constrained generalized coordinates, and Newton-Euler and Lagrange equations of motion.

Prerequisite: ME 2320, MATH 2339, MATH 2343 or permission of the instructor.

ME 7322 Vibrations

Fundamentals of vibrations with application of simple machine and structural members. Harmonic motion, free and forced vibration, resonance, damping, isolation, and transmissibility. Single, multiple, and infinite degree-of-freedom systems. *Prerequisite:* ME 2320, MATH 2343, or permission of the instructor.

ME 7326 Vehicle Dynamics

Modeling of wheeled vehicles to predict performance, handling, and ride. Effects of vehicle center of mass, tire-characteristic traction and slip, engine characteristics, and gear ratios of performance. Suspension design, steady-state handling models of four-wheeled vehicles and car-trailer systems to determine over-steer and under-steer characteristics, critical speeds, and stability. Multi-degree-of-freedom ride models, including tire and suspension compliance. Computer animation and simulations. *Prerequisite:* ME 2320 or permission of the instructor.

ME 7346 Optimal and Robust Control

The course addresses topics and concepts for linear systems control including controllability, observability, state feedback, and observers. Optimal control is presented along with stochastic optimal control, LQG, and Kalman filter. The H_2 , H_∞ , and μ robust control techniques and the sliding mode control of a linear system are presented. *Prerequisite:* ME 4360, ME 5302 or consent of instructor.

ME 7347 Frequency Domain Methods in Linear Control Systems

The course includes analysis and design of automatic control systems for linear problems using frequency domain methods. Topics include performance analysis using Bode plots, stability analysis using Nyquist criterion, robustness analysis using gain margin, phase margin, and delay margin, controller design through loop shaping for meeting performance specifications, and an introduction to robust control. *Prerequisites:* ME 4360.

Mechanics and Manufacturing

ME 7312 Continuum Mechanics

In this course, students will develop a thorough understanding of fundamental principles governing deformations, constitutive behavior and stress responses of a continuum. They will also learn to formulate mechanics problems rigorously and concisely by using tensorial, index or engineering notations. In addition, they will become able to apply general theories to solve representative problems in solid and fluid mechanics. *Prerequisites:* ME/CEE 7340 or equivalent, MATH 3302, MATH 3304, MATH 3313.

ME 7315 Optics Laser-Assisted Manufacturing

The course includes analysis and design of automatic control systems for linear problems using frequency domain methods. The primary objective is for students to develop a basic knowledge of geometrical and physical optics, introduction to laser theory, laser-material interactions, and laser-assisted manufacturing. *Prerequisites:* ME 3332, graduate standing.

ME 7319 Advanced Mechanical Behavior of Materials (core)

A senior-graduate course that relates mechanical behavior on a macro- and microscopic level to design. Topics include macroscopic elasticity and plasticity, viscoelasticity, yielding, yield surfaces, work hardening, geometric dislocation theory, creep, temperature-dependent and environment-dependent mechanical properties. *Prerequisite:* ME 2340, ME 3340, or permission of the instructor.

ME 7327 Dynamic Characterization of Materials

In many cases, mechanical response of materials subjected to impact (high strain-rate) loadings are different from that under quasi-static loadings. Aspects such as transient stress wave propagation and damage/microstructure evolution within short time durations are key to understanding the dynamic behavior of materials. This course introduces a great variety of Kolsky bar-related dynamic experimental techniques, based on the stress wave theory, for the characterization of a broad range of materials. Students will be exposed to both classroom lecturing and lab practices.

Prerequisite: Graduate Standing.

ME 7338 Nontraditional Manufacturing Processes

Explores difficult-to-machine materials and the increased geometrical complexity of components that have resulted in the development of nontraditional manufacturing processes based on the application of electrical, chemical, ultrasonic, magnetic, and photonic sources of energy. Introduces fundamentals of materials processing by laser beam, electron beam, ion beam, abrasive waterjet, ultrasonic machining, electro-discharge machining, chemical and electrochemical machining, and hybrid machining (laser beam, plasma arc, and waterjet assisted machining). Emphasizes the additive manufacturing processes as one of the fastest developing disciplines in materials processing. Covers theoretical problems and practical considerations related to the nontraditional manufacturing processes. *Prerequisites:* ME 3340, 3370; a basic understanding of manufacturing processes, mechanical and physical properties of materials, and physics.

ME 7340 Introduction to Solid Mechanics (core)

Three dimensional stress and strain, failure theories, introduction to two-dimensional elasticity, torsion of prismatic members, beams on elastic foundation, introduction to plates and shells, and energy methods. *Prerequisites:* ME 2340 and MATH2343.

ME 7361 Matrix Structural Analysis

A systematic approach to formulation of force and displacement method of analysis; representation of structures as assemblages of elements; computer solution of structural systems. *Prerequisite:* ME 3350 or permission of the instructor.

ME 7364 Introduction to Structural Dynamics

Dynamic responses of structures and behavior of structural components to dynamic loads and foundation excitations; single- and multi-degree-of-freedom systems response and its applications to analysis of framed structures; introduction to systems with distributed mass and flexibility. *Prerequisite:* MATH 2343 or permission of the instructor.

Thermal and Fluid Sciences

ME 7318 Microfluidics and Microfabrication

Review of fundamentals of fluid mechanics; Introduction to micro-scale liquid flows; Electrokinetic transport phenomena and their applications; Microfluidic mixing; Photo-lithography based micro-fabrication; introduction to computational fluid dynamics software COMSOL; Microfluidic device design, fabrication and characterization. *Prerequisite:* Graduate Standing.

ME 7330 Intermediate Heat Transfer (core)

Application of the principles of conduction, convection, and radiation heat transfer. Steady and unsteady state, special configurations, numerical and analytical solutions, and design are topics included. *Prerequisite:* ME 3332 or permission of instructor.

ME 7331 Advanced Thermodynamics

Laws of thermodynamics, availability, irreversibility, real gases and mixtures, thermodynamic relations and generalized charts, combustion, chemical and phase equilibrium, and computational combustion. *Prerequisites:* ME 2331 and ME 3341 or permission of the instructor.

ME 7332 Heat Transfer in Biomedical Sciences

Fundamentals of heat transfer in medicine and biology. Biothermal properties. Thermal regulation processes. Biomedical heat transfer processes with applications in: tissue laser radiation, freezing and thawing of biological materials, cryosurgery, and others. *Prerequisite:* ME 3332 or permission of the instructor.

ME 7333 Transport Phenomena in Porous Media

Fractals and their role in characterizing complex structures. Fundamental concepts of momentum, heat, and mass transport through heterogeneous (e.g., composites, porous) materials. Emphasis is placed on the mathematical modeling of heat and mass transfer in heterogeneous and fully saturated systems. Relevant industrial and natural applications are presented throughout the course. *Prerequisites:* ME 2342 and ME 3332 or permission of instructor.

ME 7336 Intermediate Fluid Dynamics (core)

Review of fundamental concepts of undergraduate fluid mechanics and introduction to advanced fluid dynamics, industrial irrotational flow, tensor notation, and the Navier-Stokes equations. *Prerequisite:* ME 2342 or permission of the instructor.

ME 7337 Introduction to Computational Fluid Dynamics: Fundamentals of Finite Difference Methods

Concepts of stability, convergence, accuracy, and consistency. Applications to linear and nonlinear model partial differential equations. Curvilinear grid generation. Advanced topics in grid generation. Beam and Warming factored implicit technique. MacCormack techniques. Solution methods for the Reynolds equation of lubrication, the boundary layer equations, and the Navier-Stokes equations. *Prerequisites:* ME 2342 and MATH 2343 or permission of the instructor.