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

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

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 7391 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.

ME 7391 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 H2, H∞, and μ robust control techniques and the sliding mode.

ME 8367 (EE 8367) Nonlinear Control

This course introduces the student to methods of the control of nonlinear systems. The course reviews phase plane analysis of nonlinear systems, Lyapunov theory, nonlinear stability and describing function analysis. Advance control techniques include feedback linearization, sliding control, and adaptive control. Special emphasis will be placed on the application of the developed concepts to the robust regulation of the response of nonlinear systems. *Prerequisite*: ME 7302/EE 7362 or permission of the instructor.

Mechanics and Manufacturing

ME 7319 Advanced Mechanical Behavior of Materials

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 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

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. *Prerequisite*s: ME 2340 and MATH 2343.

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.

ME 7391 Continuum Mechanics

Develop a thorough understanding of fundamental principles governing deformations, constitutive behavior and stress responses of a continuum; learn to formulate mechanics problems rigorously and concisely by using tensorial, index or engineering notations; and apply general theories to solve representative problems in solid and fluid mechanics.

ME 7394 Optics Laser-Assisted Manufacturing

Introduction to basic geometrical and physical optics, followed by an introduction to lasers and laser beam propagation and more advanced topics in laser fundamentals and laser-material interactions, with an emphasis on thermal processes. Applications of lasers to materials processing and manufacturing will be discussed, including (but not limited to) laser cutting, welding, micromachining, laser surgery, micromachining, and nanotechnology. A brief introduction to laser safety will also be provided. A major component of the course will be independent student projects.

ME 8340 Theory of Elasticity

Covers stress, strain, and stress-strain relationships for elastic bodies, classical solutions of two- and three-dimensional problems, and the use of the Airy stress function. Prerequisite: ME 7340 or permission of instructor.

ME 8364 Finite Element Methods in Structural and Continuum Mechanics

Theory and application of finite element; two- and three-dimensional elements; bending elements; applications to buckling, and dynamic problems. *Prerequisite*: ME 7361 or permission of the instructor.

Thermal and Fluid Sciences

ME 7330 Intermediate Heat Transfer

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

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.

ME 8386 Convection Heat Transfer

Advanced topics in forced convection heat transfer using analytical methods and boundary-layer analysis. Laminar and turbulent flow inside