ENGINEERING MECHANICS

Donald V. Chase, Department Chairperson

Master of Science in Engineering Mechanics (EME)

The program of study for the degree of Master of Science in Engineering Mechanics requires 30 semester hours of credit consisting of the following:

EGM 503	Introduction to Continuum Mechanics	3
EGM 533	Theory of Elasticity	3
EGM 546	Finite Element Analysis I	3
MTH 535	Partial Differential Equations	3
MTH 551	Methods of Mathematical Physics	3
Three elective semester hours in 1) engineering mechanics, 2) mathematics, and 3) engineering or basic science		9
Six semester hours of research on an approved thesis. Thesis credit may be replaced by six semester hours of coursework only with the approval of both the advisor and the department chair.		6
Total Hours		30

See also Master's Degree Requirements in School of Engineering section in the bulletin and consult with the advisor.

Courses

EGM 500. Introduction to Numerical Methods. 3 Hours
Numerical analysis topics include the solution of systems of linear and nonlinear algebraic equations; matrix eigenvalue problems; ordinary differential equations; optimization techniques; numerical integration and interpolation. Engineering applications presented. Computer programming required.

EGM 502. Advanced Engineering Analysis. 3 Hours
Detailed analysis of engineering problems using laws of nature, fundamental engineering principles, mathematics, computers, and practical experience to construct, resolve, and test analytic models of physical events. Emphasis is on the use of the professional engineering approach which includes formulation of the problem, assumptions, plan or method of attack, solving the problem, and checking and generalizing results.

EGM 503. Introduction to Continuum Mechanics. 3 Hours
Tensors, calculus of variations, Lagrangian and Eulerian descriptions of motion. General equations of continuum mechanics, constitutive equations of mechanics, thermodynamics of continua. Specialization to cases of solid and fluid mechanics. Prerequisite(s): EGM 303 or equivalent.

EGM 504. Fundamentals of Fluid Mechanics. 3 Hours
An advanced course in fluid mechanics with emphasis on the derivation of conservation equations and the application of constitutive theory. Navier-Stokes equations. Ideal fluid approximation. Exact and approximate solutions to classical viscous and inviscid problems. Compressible and incompressible flows. Prerequisite(s): EGM 503.

EGM 506. Mechanical Behavior of Materials. 3 Hours
Fundamental relationships between the structure and mechanical behavior of materials. Includes fundamentals of stress and strain, the physical basis for elastic deformation, elementary dislocation theory and plastic deformation, strengthening mechanisms, yield criteria and their application to biaxial and multi-axial behavior and failure, fracture and toughening mechanisms, creep and creep rupture, behavior and failure of cellular solids, and fatigue. Prerequisite(s): EGM 303.

EGM 511. Experimental Stress Analysis. 3 Hours
Study of the experimental analysis of stress as an aid to design for strength and economy with emphasis on electrical strain gages. Also, photoelasticity, brittle coatings, analogies, structural similitude. Two hours lecture and one three-hour laboratory period per week. Prerequisite(s): EGM 303 or equivalent.

EGM 519. Analytic Dynamics. 3 Hours
Dynamical analysis of a system of particles and rigid bodies; Lagrangian and Hamiltonian formulation of equations of motion; classical integrals of motion. Stability analysis of linear and nonlinear systems. Prerequisite(s): EGM 202, MTH 219 or equivalent; or permission of instructor.

EGM 531. Linear Viscoelasticity. 3 Hours
Principles of viscoelasticity; Kelvin and Maxwell models of viscoelastic materials; creep and relaxation phenomena; application of hereditary integral and complex compliance; correspondence principle wave propagation and vibrational response. Prerequisite(s): MTH 219 and EGM 303 or equivalent.

EGM 533. Theory of Elasticity. 3 Hours
Three-dimensional stress and strain at a point; equations of elasticity in Cartesian and curvilinear coordinates; methods of formulation of equations for solution, plane stress and plane strain; energy formulations; numerical solution procedures. Prerequisite(s): EGM 303 or equivalent. Corequisite(s): EGM 503.

EGM 534. Theory: Plates & Shells. 3 Hours
Theory of plates: small and large displacement theories of thin plates; shear deformation; buckling; sandwich plate theory. Thin shell theory: theory of surfaces; thin shell equations in orthogonal curvilinear coordinates; bending, membrane, and shallow shell theories. Prerequisite(s): EGM 533.

EGM 536. Random Vibrations. 3 Hours
Introduction to probability distribution; characterization of random vibrations; harmonic analysis; auto- and cross-correlation and spectral density; coherence; response to single and multiple loadings; Fast Fourier Transform (FFT); applications in vibrations, vehicle dynamics, fatigue, etc. Prerequisite(s): MEE 319; computer programming; permission of instructor.

EGM 538. Introduction to Aeroelasticity. 3 Hours
Study of the effect of aerodynamic forces on a flexible aircraft. Flexibility coefficients and natural modes of vibration. Quasi-steady aerodynamics. Static aeroelastic problems; wing divergence and dynamic aeroelasticity; wing flutter. An introduction to structural stability augmentation with controls. Prerequisite(s): AEE 501.

EGM 540. Composite Design. 3 Hours
Design with fiber reinforced composite materials. Fiber and resin selection, laminate design, bending and torsion of stiffening elements, open and filled holes, joining methods, fatigue, damage tolerance, building block approach, design Prerequisite(s): EGM 303 or equivalent.

EGM 541. Composite Materials. 3 Hours
Introduction to the mechanical response of fiber-reinforced composite materials with emphasis on the development of experimental methodology. Analytical topics include stress-strain behavior of anisotropic materials, laminate mechanics, and strength analysis. Theoretical models are applied to the analysis of experimental techniques used for characterizing composite materials. Lectures are supplemented by laboratory sessions in which characterization tests are performed on contemporary composites. Prerequisite(s): EGM 303 or equivalent.

EGM 543. Analytical Mechanics Composite Materials. 3 Hours
Analytical models are developed for predicting the mechanical and thermal behavior of fiber-reinforced composite materials as a function of constituent material properties. Both continuous and discontinuous fiber-reinforced systems are considered. Specific topics include basic mechanics of anisotropic materials, micro-mechanics and lamination theory, free edge effects, and failure criteria. Prerequisite(s): EGM 303 or equivalent.

EGM 545. Computational Methods Design. 3 Hours
Modeling of mechanical systems and structures, analysis by analytical and numerical methods, development of mechanical design criteria and principles of optimum design and analysis, use of the digital computer as an aid in the design of mechanical elements. Prerequisite(s): Computer programming. Co-requisite(s): Computer programming.

EGM 546. Finite Element Analysis I. 3 Hours
Fundamental development of the Finite Element Method (FEM) and solution of field and structural problems. Variational principles and weak, forms; finite element discretization; shape functions; finite elements for field problems; bar, beam, plate, and shell elements; isoparametric finite elements; stiffness, nodal force, and mass matrices; matrix assembly procedures; computer coding techniques; modeling decisions; program output interpretation. Emphasis on a thorough understanding of FEM theory and modeling techniques. Prerequisite(s): EGM 503 or EGM 533.

EGM 547. Finite Element Analysis II. 3 Hours
Advanced topics: heat transfer; transient dynamics; nonlinear analysis; substructuring and static condensation; effects of inexact numerical integration and element incompatibility; patch test; frontal solution techniques; selected topics from the recent literature. Prerequisite(s): EGM 546.

EGM 548. Energy Methods: Solid Mechanics. 3 Hours
Development of fundamental energy principles; virtual displacements, strain energy, Castigliano's theorems, minimum potential energy principles. Applications to engineering problems; redundant structures, buckling, static and dynamic analysis. Prerequisite(s): EGM 503 or EGM 533.

EGM 549. Theory of Elastic Stability. 3 Hours
Introduction to stability theory; buckling of plates and shells; influence of initial imperfections; nonlinear analysis; numerical solution methods. Prerequisite(s): EGM 533.

EGM 552. Boundary Layers. 3 Hours
Development of the Prandtl boundary layer approximation in two and three dimensions for both compressible and incompressible flow. Exact and approximate solutions for laminar flows. Unsteady boundary layers. Linear stability theory and transition to turbulence. Empirical and semi-empirical methods for turbulent boundary layers. Higher order boundary layer theory. Prerequisite(s): EGM 504 or equivalent.

EGM 553. Compressible Flow. 3 Hours
Fundamental equations of compressible flow. Introduction to flow in two and three dimensions. Two-dimensional supersonic flow, small perturbation theory, method of characteristics, oblique shock theory. Introduction to unsteady one-dimensional motion and shock tube theory. Method of surface singularities. Prerequisite(s): EGM 503.

EGM 570. Fracture Mechanics. 3 Hours
Application of the principles of fracture mechanics to problems associated with fatigue and fracture in engineering structures. Development of models that apply to a range of materials, geometries, and loading conditions. Prerequisite(s): EGM 506 or permission of instructor.

EGM 575. Fracture & Fatigue of Metals & Alloys I. 3 Hours
Effects of microstructure on the fracture and fatigue behavior of engineering metals and alloys with the special emphasis on static and dynamic brittle and ductile failures and static and fatigue crack initiation. Alloy fracture resistance, fracture toughness, fatigue behavior, and methods to improve fracture and fatigue behavior will be discussed in detail. Various analytical techniques for failure analysis of structural components will be presented. A practical failure analysis project will be performed. Prerequisite(s): MAT 501 or EGM 506 or permission of instructor.

EGM 576. Fracture & Fatigue II. 3 Hours
This course will cover the areas of the effects of microstructure on fatigue crack propagation on fracture and fatigue. This includes fatigue life prediction, damage tolerance approach to component design and microstructural and structural synthesis for optimum behavior. Specific material-related aspects of fatigue mechanisms, fracture mechanics approach, and failure analysis will also be covered. Prerequisite(s): EGM 575 or equivalent.

EGM 590. Selected Readings in Engineering Mechanics. 3 Hours
Directed readings in a designated area, arranged and approved by the student's faculty advisor and the department chair. May be repeated.

EGM 595. Special Problems in Engineering Mechanics. 3 Hours
Special topics arranged and approved by the student's faculty advisor and the department chair.

EGM 598. Project. 3 Hours
Project in Engineering Mechanics.

EGM 599. Thesis. 3-6 Hours
Thesis in Engineering Mechanics.