

# MEMA - MECHANICS AND MATERIALS

## MEMA 601 Theory of Elasticity

**Credits 3. 3 Lecture Hours.** Analysis of stress and strain in two and three dimensions, equilibrium and compatibility equations, strain energy methods; torsion of noncircular sections; flexure; axially symmetric problems. **Prerequisite:** Mechanics of Materials, Advanced Calc Different Equations. **Cross Listing:** AERO 605 and MEEN 603.

## MEMA 602 Continuum Mechanics

**Credits 3. 3 Lecture Hours.** Development of field equations for analysis of continua (solids as well as fluids); conservation laws; kinematics, constitutive behavior of solids and fluids; applications to aerospace engineering problems involving solids and fluids. **Prerequisite:** Graduate classification. **Cross Listing:** AERO 603 and MEEN 608.

## MEMA 606 Multifunctional Materials

**Credits 3. 3 Lecture Hours.** In-depth analysis of multifunctional materials and composites, and their novel applications. **Prerequisites:** MEMA 602/ AERO 603, MSEN 601. **Cross Listing:** AERO 606 and MSEN 606.

## MEMA 608 Nanomechanics

**Credits 3. 3 Lecture Hours.** Application of mechanics concepts to nano-scale behavior of materials; review of continuum mechanics; extensions to generalized continua; nonlocal elasticity; nano-scale plasticity; focus on multi-scale modeling - dislocation dynamics; quasi-continuum method; molecular dynamics with introductions to quantum mechanics and statistical mechanics. **Prerequisite:** AERO 603. **Cross Listing:** AERO 608 and MSEN 608.

## MEMA 611 Fundamentals of Engineering Fracture Mechanics

**Credits 3. 3 Lecture Hours.** Understanding of the failure of structures containing cracks with emphasis on mechanics; linear elastic fracture mechanics, complex potentials of Muskhelishvili and Westergaard, J-integral, energy release rate, R-curve analysis, crack opening displacement, plane strain fracture toughness testing, fatigue crack propagation, fracture criteria, fracture of composite materials. **Prerequisite:** AERO 603.

## MEMA 612/AERO 612 Wave Propagation in Isotropic and Anisotropic Solids

**Credits 3. 3 Lecture Hours.** Mathematical and experimental methods of studying stress waves with emphasis on anisotropic solids, e.g., fiber-reinforced composite materials; waves in an unbounded medium, in a half-space, in rods; waves in a general anisotropic medium; wave surface, slowness surface, velocity surface, energy velocity and group velocity. **Prerequisite:** Graduate classification; MEMA 602, or approval of instructor. **Cross Listing:** AERO 612/MEMA 612.

## MEMA 613/MSEN 610 Principles of Composite Materials

**Credits 3. 3 Lecture Hours.** Classification and characteristics of composite materials; micromechanical and macromechanical behavior of composite laminate; macromechanical behavior of laminates using classical laminate theory; interlaminar stresses and failure modes; structural design concepts, testing and manufacturing techniques.

**Prerequisite:** Graduate classification; MEMA 602, or approval of instructor. **Cross Listing:** MSEN 610/MEMA 613.

## MEMA 616/MSEN 636 Damage and Failure in Composite Materials

**Credits 3. 3 Lecture Hours.** Mechanisms and models related to damage and failure in composite materials subjected to mechanical loads.

**Prerequisite:** Courses in composite materials, elasticity. **Cross Listing:** MSEN 636/MEMA 616.

## MEMA 625/AERO 617 Micromechanics

**Credits 3. 3 Lecture Hours.** Eigenstrains; inclusions, and inhomogeneities; Eshelby's solution for an ellipsoidal inclusion; Eshelby's equivalent inclusion method; effective elastic properties of composites; composite spheres and cylinders models; bounds on effective moduli; Hashin-Shtrikman bounds; applications to fiber, whisker and particulate reinforced composites; introduction to micromechanics of inelastic composites and solids with damage. **Prerequisite:** MEMA 602. **Cross Listing:** AERO 617/MEMA 625.

## MEMA 626/AERO 618 Mechanics of Active Materials

**Credits 3. 3 Lecture Hours.** Introduction to coupled field theories: constitutive response of materials with thermal and electromagnetic coupling; microstructural changes due to phase transformations; shape memory alloys; piezoelectric and magnetostrictive materials; active polymers and solutions; micromechanics of active composites. **Prerequisite:** MEMA 602. **Cross Listing:** AERO 618/MEMA 626.

## MEMA 634/CVEN 753 Damage Mechanics of Solids and Structures

**Credits 3. 3 Lecture Hours.** Damage mechanics; constitutive modeling of damage behavior of materials; application of thermodynamic laws; computational techniques for predicting progressive damage and failure; plasticity; viscoplasticity; viscoelasticity; cohesive zone modeling; fatigue and creep damage; damage in various brittle and ductile materials (e.g., metal, concrete, polymer, ceramic, asphalt, biomaterial, composites). **Prerequisite:** CVEN 633 or approval of instructor. **Cross Listing:** CVEN 753/MEMA 634.

## MEMA 641/MSEN 641 Plasticity Theory

**Credits 3. 3 Lecture Hours.** Theory of plastic yield and flow of two and three-dimensional bodies; classical plasticity theories, unified viscoplastic theories, numerical considerations; applications and comparisons of theory to experiment. **Prerequisite:** MEMA 602. **Cross Listing:** MSEN 641/MEMA 641.

## MEMA 646 Introduction to the Finite Element Method

**Credits 3. 3 Lecture Hours.** Weak or variational formulation of differential equations governing one- and two-dimensional problems of engineering; finite element model development and analysis of standard problems of solid mechanics (bars, beams and plane elasticity), heat transfer and fluid mechanics; time-dependent problems; computer implementation and use of simple finite element codes in solving engineering problems.

**Prerequisite:** Senior or graduate classification.

## MEMA 647 Theory of Finite Element Analysis

**Credits 3. 3 Lecture Hours.** Finite elements models of a continuum; virtual work principle; plane stress and plane strain finite element models; bending of plates; axisymmetric problems; three-dimensional stress analysis; isoparametric formulations; finite element computer programs to solve typical structural problems. **Prerequisite:** Graduate classification or approval of instructor.

## MEMA 648 Nonlinear Finite Element Methods in Structural Mechanics

**Credits 3. 3 Lecture Hours.** Tensor definitions of stress and strain, finite strain, geometric and material nonlinearities; development of nonlinear finite element equations from virtual work; total and updated Lagrangian formulations; solution methods for nonlinear equations; computational considerations; applications using existing computer programs. **Prerequisite:** MEMA 647 or equivalent.

## MEMA 649/AERO 649 Generalized Finite Element Methods

**Credits 3. 3 Lecture Hours.** Systemic introduction to the theory and practice of generalized finite element (FE) methods, including GFEM, the hp-cloud method, particle methods and various meshless methods with similar character; precise formulation of the methods are presented; known theoretical results for convergence; important issues related to implementation, issues of numerical integration. **Prerequisite:** Graduate student status. **Cross Listing:** AERO 649/MEMA 649.

## MEMA 651 Viscoelasticity of Solids and Structures I

**Credits 3. 3 Lecture Hours.** Linear, viscoelastic mechanical property characterization methods, time-temperature equivalence, multiaxial stress-strain equations; viscoelastic stress analysis; the correspondence principle, approximate methods of analysis and Laplace transform inversion, special methods; static and dynamic engineering applications; nonlinear behavior. **Prerequisite:** Approval of instructor.

## MEMA 670 Computational Materials Science and Engineering

**Credits 3. 3 Lecture Hours.** Modern methods of computational modeling and simulation of materials properties and phenomena, including synthesis, characterization, and processing of materials, structures and devices; quantum, classical, and statistical mechanical methods, including semi-empirical atomic and molecular-scale simulations, and other modeling techniques using macroscopic input. **Prerequisites:** Approval of instructor; graduate classification. **Cross Listing:** MSEN 670 and CHEN 670.

## MEMA 689 Special Topics in...

**Credits 1 to 4. 1 to 4 Lecture Hours.** Selected topics in an identified area of mechanics and materials. May be repeated for credit. **Prerequisite:** Approval of instructor.