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/AERO 603 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 606 and MEMA 602.

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/AERO 603/MEMA 602, 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/MEMA 602.
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 602.

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: MEMA 601 or AERO 603/MEMA 602.
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 laminae;
macromechanical behavior of laminates using classical laminate theory;
interlaminar stresses and failure modes; structural design concepts,
testing and manufacturing techniques.
Prerequisite: MEMA 602/AERO 603.
Cross Listing: MSEN 610/MEMA 613.

MEMA 616 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: AERO 616 and MSEN 636.

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/AERO 603.
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/AERO 603.
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 653 or approval of instructor.
Cross Listing: CVEN 753/MEMA 634.

MEMA 635 Structural Analysis of Composites
Credits 3.3 Lecture Hours.
Formulation and analysis structural response of laminated composite
components; bending, vibration and stability of laminated composite
plates; interlaminar stresses, effect of shear deformation on structural
response; numerical modeling of laminated plates.
Prerequisite: MEMA 613/MSEN 610.

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/AERO 603.
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.