# Mechanics (MECH)

**Courses**

**MECH 002 Elementary Engineering Mechanics 3 Credits**
Static equilibrium of particles and rigid bodies. Elementary analysis of simple truss and frame structures, internal forces, stress, and strain. Credit will not be given for both MECH 002 and MECH 003.
**Prerequisites:** (MATH 022 or MATH 052 or MATH 032) and (PHY 010 or PHY 011)
**Can be taken Concurrently:** MATH 022, MATH 052, MATH 032

**MECH 003 Fundamentals of Engineering Mechanics 0,3 Credits**
Static equilibrium of particles and rigid bodies. Analysis of simple truss and frame structures, internal forces, stress, strain, and Hooke's Law, torsion of circular shafts; pure bending of beams. Is intended as a prerequisite for MECH 012. Credit not given for both MECH 002 and MECH 003.
**Prerequisites:** (MATH 022 or MATH 032) and PHY 011
**Can be taken Concurrently:** MATH 022, MATH 032

**MECH 012 Strength of Materials 0,3 Credits**
Stress due to normal, bending, and shear loads in beams; stress transformations via Mohr's circle; principal stress analysis; plastic yield criteria; design of thin-walled pressure vessels; deflection of beams and static indeterminacy; finite element analysis of simple structures; stresses in thick-walled cylinders; stress concentration effects.
**Prerequisites:** MECH 003 and (MATH 023 or MATH 033)
**Can be taken Concurrently:** MATH 023, MATH 033

**MECH 050 Supplemental Topis in Mechanics 1-2 Credits**
Completion of material for MECH courses transferred from other institutions. Student will be scheduled for that part of MECH course that is required for completion of missing material. Subject matter and credit hours to be determined by department chair for each student.

**MECH 102 Dynamics 3 Credits**
Particle dynamics, work-energy, impulse-momentum, impact, systems of particles; kinematics of rigid bodies, kinetics of rigid bodies in plane motion, energy, momentum, eccentric impact.
**Prerequisites:** (MECH 002 or MECH 003) and (MATH 023 or MATH 033)
**Can be taken Concurrently:** MATH 023, MATH 033

**MECH 103 Principles of Mechanics 4 Credits**
Composition and resolution of forces; equivalent force systems; equilibrium of particles and rigid bodies; friction. Kinematics and kinetics of particles and rigid bodies; relative motion; work and energy; impulse and momentum.
**Prerequisites:** (MATH 023 or MATH 033) and (PHY 010 or PHY 011)

**MECH 300 Apprentice Teaching 3 Credits**

**MECH 302 Advanced Dynamics 3 Credits**
Fundamental dynamic theorems and their application to the study of the motion of particles and rigid bodies, with particular emphasis on three-dimensional motion. Use of generalized coordinates; Lagrange's equations and their applications.
**Prerequisites:** MATH 205 and (MECH 102 or MECH 103)

**MECH 305 Advanced Mechanics of Materials 3 Credits**
Strength, stiffness, and stability of mechanical components and structures. Fundamental principles of stress analysis: three-dimensional stress and strain transformations, two-dimensional elasticity, contact stresses, stress concentrations, energy and variational methods. Stresses and deformations for rotating shafts, thermal stresses in thick-walled cylinders, curved beams, torsion of prismatic bars, and bending of plates. Projects relate analysis to engineering design.
**Prerequisites:** MECH 012 and MATH 205

**MECH 307 Mechanics of Continua 3 Credits**
Fundamental principles of the mechanics of deformable bodies. Study of stress, velocity and acceleration fields. Compatibility equations, conservation laws. Applications to two-dimensional problems in finite elasticity, plasticity, and viscous flows.
**Prerequisites:** MECH 305

**MECH 312 Finite Element Analysis 3 Credits**
Basic concepts of analyzing general media (solids, fluids, heat transfer, etc.) with complicated boundaries. Emphasis on mechanical elements and structures. Element stiffness matrices by minimum potential energy. Isoparametric elements. Commercial software packages (ABAQUS, NISA) are used. In addition, students develop and use their own finite element codes. Applications to design.
**Prerequisites:** MECH 012

**MECH 313 Fracture Mechanics 3 Credits**
Fracture mechanics as a foundation for design against or facilitation of fracture. Fracture behavior of solids; fracture criteria; stress analysis of cracks; subcritical crack growth, including chemical and thermal effects; fracture design and control, and life prediction methodologies.
**Prerequisites:** MECH 012 and MATH 205

**MECH 326 Aerodynamics 3 Credits**
Application of fluid dynamics to flows past lifting surfaces, and inside nozzles and diffusers. Fundamentals of potential flow are covered including: the Kutta-Joukowski theorem, physical basis for the Kutta condition, thin airfoil theory, sectional pressure profiles and separation, and lifting line theory. Compressible isentropic subsonic/supersonic and non-isentropic supersonic flows are covered including: supersonic airfoils, shock waves, shock reflections, and expansion fans. Credit will not be given for both MECH 326 and MECH 426.
**Prerequisites:** ME 231

**MECH 328 Aircraft Design Engineering 3 Credits**
An in-depth course in the design process for modern aircraft from concept to final design, focusing on design layout and analysis for specific mission requirements. Students follow this process to design an aircraft using CAD and CFD applications. Design models can be fabricated and further developed in related courses.
**Prerequisites:** ME 255 or MECH 326

**MECH 350 Special Topics 3 Credits**
A study of some field of engineering mechanics not covered elsewhere. Consent of department required.

**MECH 404 Mechanics & Behavior of Structural Members 3 Credits**
Behavior of structural members under a variety of loading conditions in the elastic and inelastic range. Introduction to the theory of elasticity and plasticity. Basics of linear elastic fracture mechanics and fatigue. Analysis of structural member behavior in axial, bending, shear, and torsion. Stability analysis of beam-columns. Beams on elastic foundations. Energy concepts and their use in structural analysis.

**MECH 406 Fundamentals of Solid Mechanics 3 Credits**
An introductory graduate course in the mechanics of solids. Topics to be addressed include: curvi-linear tensor analysis, analysis of strain and nonlinear kinematics, stress, work conjugate stress-strain measures, conservation laws and energy theorems, variational calculus, isotropic and anisotropic linear elasticity, boundary value problems, beam and plate theories.

**MECH 408 Introduction to Elasticity 3 Credits**
This course is a first graduate course in solid mechanics. It addresses: kinematics and statics of deformable elastic solids; compatibility, equilibrium and constitutive equations; problems in plane elasticity and torsion; energy principles, approximate methods and applications.

**MECH 413 Fracture Mechanics 3 Credits**
Elementary and advanced fracture mechanics concepts; analytical modeling; fracture toughness concept; fracture toughness testing; calculation of stress intensity factors; elastic-plastic analysis; prediction of crack trajectory; fatigue crack growth and environmental effects; computational methods in fracture mechanics; nonlinear fracture mechanics; fracture of composite structures; application of fracture mechanics to design.

**MECH 418 Finite Element Methods 3 Credits**
Finite element approximations to the solution of differential equations of engineering interest. Linear and nonlinear examples from heat transfer, solid mechanics, and fluid mechanics are used to illustrate applications of the method. The course emphasizes the development of computer programs to carry out the required calculations. Must have knowledge of a high-level programming language.

**MECH 424 Unsteady Flows 3 Credits**
This course examines the forces and flows that arise when rigid or flexible objects produce unsteadiness in a surrounding flow. The concepts of added mass and circulatory forces, hydrodynamic impulse, and vortex force are introduced. For unsteady lifting surfaces, classic theories such as Theodorsen, and von Kármán and Sears are examined. Unsteady flows produced by bluff bodies, such as vortex shedding from a cylinder, are discussed as well as unsteady flows from oscillating bodies, such as flying and swimming animals.

**MECH 425 Analytical Methods in Dynamics and Vibrations 3 Credits**
This course will mainly cover the following topics: coordinate systems, conservations laws, inertial frames, systems of particles, DAE sets, variable-mass systems, transport equation, review of some of the basic concepts from variational calculus, D'Alembert's principle, Hamilton's principle, Lagrange multipliers, generalized momenta, 3D rigid-body motion, Inertia matrices, Euler angles, inertial and elastic coupling, discrete eigenvalue problem, linearization of nonlinear systems, chaotic systems, Hamilton's principle for continuous systems, Torsion, Sturm-Liouville equations, Rayleigh's quotient, finite-element eigen-problems, interpolating functions, combined-effect vibrations, and some other related topics.

**MECH 426 Advanced Aerodynamics 3 Credits**
Application of the fluid dynamics of lifting surfaces, nozzles, and diffusers. Fundamentals of potential flow are covered including: the Kutta-Joukowski theorem, thin airfoil theory, and lifting line theory. Numerical panel methods are introduced. Compressible isentropic subsonic/supersonic and non-isentropic supersonic flows are covered including: supersonic airfoils, shock waves, and expansion fans. Experiments investigating vortex shedding, finite-span wings, sectional pressure distribution, and a hydraulic jump-shock analogy are examined. Credit will not be given for both MECH 326 and MECH 426.

**MECH 427 Unsteady Flows 3 Credits**
This course examines the forces and flows that arise when rigid or flexible objects produce unsteadiness in a surrounding flow. The concepts of added mass and circulatory forces, hydrodynamic impulse, and vortex force are introduced. Unsteady forces of maneuvers and wing-gust encounters are examined with classic theories such as Theodorsen, and von Kármán and Sears. Unsteady numerical panel methods are introduced. Unsteady flows produced by bluff bodies and oscillating bodies are discussed.

**MECH 432 Inelastic Behavior Of Materials 3 Credits**
Time-independent and dependent inelastic material behavior. Time-independent plasticity. Yield criteria in multi-dimensions, J2 incremental plasticity in multi-dimensions with associated flow rule. Numerical integration of plasticity equations by radial return and other methods. Deformation theory of plasticity. Time dependent behavior including linear viscoelasticity and nonlinear creep behavior. Nonlinear material behavior at elevated temperatures.

**MECH 450 Special Problems 3 Credits**
An intensive study of some field of applied mechanics not covered in more general courses.
**Repeat Status:** Course may be repeated.