

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 Topics 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. Normal force calculations in inviscid flows. Use of conformal mappings in two dimensional airfoil theory. Kutta condition at a trailing edge; physical basis. Viscous boundary layers. Thin airfoil theory. Section design; pressure profiles and separation. Lifting line theory. Compressible subsonic flows; Prandtl-Glauert Rule. Airfoil performance at supersonic speeds.

Prerequisites: ME 231

MECH 328 Fundamentals of Aircraft Design 3 Credits

Review of dynamic pressure, lift, drag. International Standard Atmosphere. Basics of wing sections. Parasitic and induced drag, best glide ratio and minimum sink of gliders. Basics of planforms, propulsion (piston/propeller and jet). Performance estimates (max speed, climb, endurance, range, stall), stability and trim, aerodynamic moments. Phugoid. Wing spar analysis. Electric aircraft.

Prerequisites: MECH 012

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 410 Theory of Elasticity II 3 Credits

Advanced topics in the theory of elasticity. The subject matter may vary from year to year and may include, theory of potential functions, linear thermoelasticity, dynamics of deformable media, integral transforms and complex-variable methods in classical elasticity. Problems of boundary layer type in elasticity; current developments on the microstructure theory of elasticity.

MECH 411 Continuum Mechanics 3 Credits

An introduction to the continuum theories of the mechanics of solids and fluids. This includes a discussion of the mechanical and thermodynamical bases of the subject, as well as the use of invariance principles in formulating constitutive equations. Applications of the theories to specific problems are given.

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 415 Stability of Elastic Structures 3 Credits

Basic concepts of instability of a structure; bifurcation, energy increment, snap-through, dynamic instability. Analytical and numerical methods of finding buckling loads of columns. Postbuckling deformations of cantilever columns. Dynamic buckling with nonconservative forces. Effects of initial imperfections. Inelastic buckling. Instability problems of thin plates and shells.

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 419 (CHE 419) Asymptotic Methods in the Engineering Sciences 3 Credits

Introductory level course with emphasis on practical applications. Material covered includes: Asymptotic expansions. Regular and singular perturbations; algebraic problems. Asymptotic matching. Boundary value problems; distinguished limits. Multiple scale expansions. W.K.B. Theory. Non-linear wave equations.

MECH 424 Unsteady Fluid Flows 3 Credits

Gas dynamics, finite amplitude disturbances in perfect and real gases; channel flows; three-dimensional acoustics; theories of the sonic boom. Motions in fluids with a free surface; basic hydrodynamics, small amplitude waves on deep water; ship waves; dispersive waves; shallow water gravity waves and atmospheric waves. Hemodynamics; pulsatile blood flow at high and low Reynolds number. Models of the interaction of flow with artery walls.

MECH 425 Analytical Methods in Dynamics and Vibrations 3 Credits

This course will mainly cover the following topics: coordinate systems, conservation 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 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 445 Nondeterministic Models in Engineering 3 Credits

Application of probability and stochastic processes to engineering problems for a variety of applications. Modeling and analysis of common nondeterministic processes. Topics are selected from the following: linear and nonlinear models for random systems; random functions; simulation; random loads and vibrations; Kalman filtering, identification, estimation, and prediction; stochastic fracture and fatigue; probabilistic design of engineering systems; and spatial point processes. Must have advanced calculus and some exposure to probability and statistics.

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.

MECH 454 Mechanics and Design of Composites 3 Credits

Mechanics of anisotropic materials. Manufacturing and measurements of mechanical properties. Stress analysis for design of composite structures. Hydrothermal effects and residual stresses. Laminate design, micromechanics of lamina. Bolted and bonded joints. Impact and damage in composites. Lectures and laboratory.