Engineering Mechanics
Administered by the Department of Aerospace Engineering

Undergraduate Study
The undergraduate courses in mechanics are intermediate between those in physics and mathematics and the professional and design courses of the several engineering curricula. In these courses the student is expected to acquire an understanding of the basic principles and analysis techniques pertaining to the static and dynamic behavior of rigid media, deformable solids, fluids, and gasses. Physical properties of engineering materials are studied in the classroom and are tested in the laboratory. General physical laws are given mathematical expression and are made suitable for use in the solution of specific problems in machine and structural design, and in the flow and measurement of fluids.

Graduate Study
The department offers graduate programs that lead to the degrees master of science, master of engineering, and doctor of philosophy with major in engineering mechanics, and minor work to students taking major work in other departments.

The master of science degree requires a thesis and a minimum of 8 research credits. It has strong research emphasis and is recommended for students who anticipate entering a doctoral program later. At least 30 credits of acceptable graduate work are required for the degree.

The master of engineering degree does not require either research credits or a thesis. However, at least two credits of acceptable creative component and at least 26 credits of acceptable graduate coursework are required. A minimum of 30 credits of acceptable graduate work is required for the degree. The program is intended to give students additional instruction at the graduate level to better qualify them for advanced professional engineering work. By careful selection of electives and perhaps additional courses during the senior undergraduate year, students should be able to qualify for the master of engineering degree with an additional year of full-time study after receiving their baccalaureate degree in one of the several engineering curricula.

Credits for creative component will be obtained by registering for E M 599 Creative Component. A written report and an oral presentation will be given to the student’s graduate committee.

The normal prerequisite to major graduate work is the completion of a curriculum substantially equivalent to that required of undergraduate students in engineering at this university. However, because of the diversity of interests in graduate work in engineering mechanics, it is possible for a student to qualify for graduate study even though undergraduate or prior graduate training has been in a discipline other than engineering—e.g., physics or mathematics.

Courses primarily for undergraduates:

E M 274. Statics of Engineering.
(3-0) Cr. 3. F.S.SS. Prereq: Credit or enrollment in MATH 166; credit or enrollment in PHYS 111 or PHYS 221
Vector and scalar treatment of coplanar and noncoplanar force systems. Resultants, equilibrium, friction, centroids, second moments of areas, principal second moments of area, radius of gyration, internal forces, shear and bending moment diagrams.

(3-0) Cr. 3. F.S.SS. Prereq: Credit or enrollment in MATH 168; credit or enrollment in PHYS 111 or PHYS 221
Vector and scalar treatment of coplanar and noncoplanar force systems. Resultants, equilibrium, friction, centroids, second moments of areas, principal second moments of area, radius of gyration, internal forces, shear and bending moment diagrams.

(3-0) Cr. 3. F.S.SS. Prereq: E M 274
Plane stress, plane strain, stress-strain relationships, and elements of material behavior. Application of stress and deformation analysis to members subject to centric, torsional, flexural, and combined loadings. Elementary considerations of theories of failure, buckling. Nonmajor graduate credit.

E M 327. Mechanics of Materials Laboratory.
(0-2) Cr. 1. F.S.SS. Prereq: Credit or enrollment in E M 324

E M 345. Dynamics.
(3-0) Cr. 3. F.S.SS. Prereq: E M 274, credit or enrollment in MATH 266 or MATH 267
Particle and rigid body kinematics, Newton’s laws of motion, kinetics of plane motion, rigid body problems using work-energy, linear, and angular impulse-momentum principles, vibrations. Nonmajor graduate credit.

(3-0) Cr. 3. S. Prereq: E M 324, MATH 266 or MATH 267, PHYS 222
The physics of ultrasonic, eddy current, and x-ray testing. Introduction to linear system concepts, wave propagation, electromagnetics and radiation. Models of the generation, scattering and reception of waves in ultrasonics, the electrical impedance changes of eddy current testing, and image formation process for x-rays. Pattern recognition methods for the interpretation of measured responses. Nonmajor graduate credit.

(Cross-listed with MAT E) (3-0) Cr. 1. S. Prereq: Credit or enrollment in MATH E 362
Application of nondestructive testing techniques to the detection and sizing of flaws in materials and to the characterization of material’s microstructure. Included are experiments in hardness, dye penetrant, magnetic particle, x-ray, ultrasonic and eddy current testing. Field trips to industrial laboratories. Nonmajor graduate credit.

(2-2) Cr. 3. F.S.SS. Prereq: E M 274

(Cross-listed with AER E) (2-2) Cr. 3. Alt. F., offered 2012. Prereq: E M 324
Introduction of different aspects of measuring deformation, strain, and stress for practical engineering problems. Strain gage theory and application. Selected laboratory experiments. Nonmajor graduate credit.

(3-0) Cr. 3. F.S. Prereq: E M 324

E M 425. Introduction to the Finite Element Method.
(3-0) Cr. 3. S. Prereq: E M 324, MATH 266 or MATH 267
Introduction of finite element analysis through applications to one-dimensional, steady-state problems such as elastic deformation, heat and fluid flow, consolidation, beam bending, and mass transport. Transient heat conduction and wave propagation. Two-dimensional triangular and quadrilateral elements. Plane problems of torsion, thermal and potential flow, stress analysis. Simple computer programs for one- and two-dimensional problems. Nonmajor graduate credit.

(Cross-listed with M E) (2-2) Cr. 3. Alt. S., offered 2012. Prereq: PHYS 221 and MATH 266 or MATH 267
Properties of sounds waves and noise metrics (pressure, power levels, etc), Sound sources and propagation. Principles of wave propagation in one-, two-, and three-dimensions. Wave reflection and transmission. Wave propagation in rectangular, cylindrical, and annular ducts. Acoustics fields for model noise sources. Introduction to aerodynamic noise sources in aircraft, aircraft engines, and wind turbines. Selected laboratory experiments. Nonmajor graduate credit.

E M 490. Independent Study.
Cr. arr. Repeatable. Prereq: Permission of instructor

E M 490H. Independent Study: Honors.
Cr. arr. Repeatable. Prereq: Permission of instructor
Courses primarily for graduate students, open to qualified undergraduates:

E M 510. Continuum Mechanics. (3-0) Cr. 3. F. Prereq: MATH 385

E M 514. Advanced Mechanics of Materials. (Cross-listed with AER E). (3-0) Cr. 3. F. Prereq: E M 324

Fundamental mechanics of linear elasticity, formulation and solution of simple elastostatic boundary value problems. Kinematics of small deformations, constitutive equations for isotropic and anisotropic media. Field equations for elastic solids, plane strain/plane stress and some classic analytical solutions such as Boussinesq, Hertz, Kirsch, Lam&acutef and Mitchell. Stress functions and potential methods and introduction to finite elements.

E M 517. Experimental Mechanics. (Cross-listed with AER E), (3-2) Cr. 4. Alt. S., offered 2012. Prereq: E M 510 or E M 514 or E M 516
Fundamental concepts for force, displacement, stress, and strain measurements. Strain gages. Full field deformation measurements with laser interferometry and digital image processing. Advanced experimental concepts at the micro and nano scale regimes.

E M 518. Waves in Elastic Solids with Applications to Ultrasonic Nondestructive Evaluation. (3-0) Cr. 3. F. Prereq: MATH 385

E M 525, Finite Element Analysis. (Cross-listed with AER E). (3-0) Cr. 3. S. Prereq: E M 425, MATH 385
Variational and weighted residual approach to finite element equations. Emphasis on two- and three-dimensional problems in solid mechanics. Isoparametric element formulation, higher order elements, numerical integration, imposition of constraints and penalty, convergence, and other more advanced topics. Use of two- and three-dimensional computer programs. Dynamic and vibrational problem eigenvalues, and time integration. Introduction to geometric and material nonlinearities.

E M 526. Boundary Element Methods in Engineering. (3-0) Cr. 3. Alt. F., offered 2012. Prereq: E M 514 or E M 516

E M 543. Introduction to Random Vibrations and Nonlinear Dynamics. (Cross-listed with M E). (3-0) Cr. 3. Alt. S., offered 2013. Prereq: 444
Vibrations of continuous systems. Nonlinear vibration phenomena, perturbation expansions; methods of multiple time scales and slowly-varying amplitude and phase. Characteristics of random vibrations; random processes, probability distributions, spectral density and its significance, the normal or Gaussian random process. Transmission of random vibration, response of simple single and two-degree-of-freedom systems to stationary random excitation. Fatigue failure due to random excitation.

E M 545. Advanced Engineering Dynamics. (3-0) Cr. 3. Alt. S., offered 2012. Prereq: E M 345, MATH 266 or MATH 267
3-D kinematics and dynamics of particles and rigid bodies. Coordinate systems, calculus of variations. Lagrange’s equations with constraints, modified Euler’s equations, torque-free motion of rigid bodies in 3-D, moment equations with constraints.

Principles of five basic NDE methods and their application in engineering inspections. Materials behavior and simple failure analysis. NDE reliability, and damage-tolerant design. Advanced methods such as acoustic microscopy, laser ultrasounds, thermal waves, computed tomography, and thermoelectrics are analyzed. Laboratory experiments on all basic methods: ultrasounds, eddy currents, x-ray, liquid penetrants, magnetic testing, and visual inspection are performed.

Theoretical acoustics: wave propagation in fluids; acoustic radiation, diffraction and scattering; nonlinear acoustics; radiation force; cavitation; and ray acoustics.

E M 564. Fracture and Fatigue. (Cross-listed with M S E, M E, AER E). (3-0) Cr. 3. Alt. F., offered 2012. Prereq: E M 324 and either M AT E 216 or M AT E 273 or M AT E 392. Undergraduates: Permission of Instructor
Materials and mechanics approach to fracture and fatigue. Fracture mechanics, brittle and ductile fracture, fracture and fatigue characteristics, fracture of thin films and layered structures. Fracture and fatigue tests, mechanics and materials designed to avoid fracture or fatigue.


Atmospheric circulations, atmospheric boundary layer wind, bluff-body aerodynamics, aeroelastic phenomena, wind-tunnel and full-scale testing, wind-load code and standards, effect of tornado and thunderstorm winds, design applications.


Courses for graduate students:

Cr. 1-6. Repeatable. Prereq: Permission of instructor

Cr. 1-6. Repeatable. Prereq: Permission of instructor

Cr. 1-6. Repeatable. Prereq: Permission of instructor

Cr. 1-6. Repeatable. Prereq: Permission of instructor

Cr. 1-6. Repeatable. Prereq: Permission of instructor

E M 697. Engineering Internship.
Cr. R. Repeatable. Prereq: Permission of DOGE (Director of Graduate Education), graduate classification
One semester and one summer maximum per academic year professional work period. Offered on a satisfactory-fail basis only.

E M 699. Research.
Cr. arr. Repeatable.