ENGINEERING MECHANICS (E M)

Courses primarily for undergraduates:

E M 274: Engineering Statics
(3-0) Cr. 3. F.S.SS.
Prereq: Credit or enrollment in MATH 166; PHYS 221
Vector analysis; analysis of force systems; resultant in two and three dimensions; free-body diagrams; equilibrium; analysis of trusses, frames, and machines; friction, belts and pulleys; shear and bending moment in beams, centroid and center of mass; second moments of areas.

E M 324: Mechanics of Materials
(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.

E M 327: Mechanics of Materials Laboratory
(0-2) Cr. 1. F.S.SS.
Prereq: E M 324
Experimental determination of mechanical properties of selected engineering materials. Experimental verification of assumptions made in 324. Use of strain measuring devices. Preparation of reports.

E M 345: Engineering 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.

E M 362: Principles of Nondestructive Testing
(Cross-listed with MAT E). (3-0) Cr. 3. S.
Prereq: PHYS 112 or PHYS 222
Radiography, ultrasonic testing, magnetic particle inspection, eddy current testing, dye penetrant inspection, and other techniques. Physical bases of tests; materials to which applicable; types of defects detectable; calibration standards, and reliability safety precautions.

E M 362L: Nondestructive Testing Laboratory
(Cross-listed with MAT E). (0-3) Cr. 1. S.
Prereq: Credit or enrollment in MAT 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.

E M 378: Mechanics of Fluids
(2-2) Cr. 3. F.S.SS.
Prereq: E M 274

E M 417: Experimental Mechanics
(Dual-listed with E M 517). (Cross-listed with AER E). (2-2) Cr. 3. Alt. F., offered even-numbered years.
Prereq: E M 324; MAT E 273
Introduction to fundamental concepts for force, displacement, stress and strain measurements for structures and materials applications. Strain gage theory and application. Full field deformation measurements with laser interferometry and digital image processing. Advanced experimental concepts at the micro- and nano-scale regimes. Selected laboratory experiments.

E M 424: Intermediate Mechanics of Materials
(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.

E M 451: Engineering Acoustics
(Cross-listed with E E, M E). (2-2) Cr. 3. Alt. S., offered even-numbered years.
Prereq: PHYS 221 and MATH 266 or MATH 267

E M 480: Ultrasonic Nondestructive Evaluation
(Cross-listed with AER E). (3-0) Cr. 3. S.
Prereq: E M 324, MATH 266 or MATH 267, PHYS 222
Introduction to stress/strain, Hooke's law, and elastic wave propagation in two dimensions in isotropic media. Ultrasonic plane-wave reflection and transmission; and simple straight-crested guided waves. Transducer construction, behavior, and performance. Simple signal analysis and discrete signal processing. The last few weeks of the course are devoted to case studies.

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

(3-0) Cr. 3. S.
Prereq: E M 510
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, Lamé, and Mitchell. Stress functions and potential methods and introduction to finite elements.

E M 517: Experimental Mechanics
(Dual-listed with E M 417). (Cross-listed with AER E). (3-2) Cr. 4. Alt. S., offered even-numbered years.
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 problems, 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 even-numbered years.
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 odd-numbered years.
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 548: Advanced Engineering Dynamics
(3-0) Cr. 3. Alt. S., offered even-numbered years.
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.

E M 550: Nondestructive Evaluation
(Cross-listed with M S E). (3-2) Cr. 4. S.
Prereq: E M 324, MATH 385
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 ultrasonics, thermal waves, and computed tomography are analyzed. Computer-based experiments on a selection of methods: ultrasonics, eddy currents, x-rays are assigned for student completion.

E M 552: Advanced Acoustics
(Cross-listed with M E). (3-0) Cr. 3. Alt. F., offered irregularly.
Prereq: E M 451
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 AER E, M E, M S E). (3-0) Cr. 3. Alt. F., offered even-numbered years.
Prereq: E M 324 and either MAT E 216 or MAT E 273 or MAT 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.
E M 566: Phase Transformation in Elastic Materials  
(Cross-listed with M E). (3-0) Cr. 3. S. 
*Prereq: EM 510 or EM 516 or EM 514*  

E M 569: Mechanics of Composite and Combined Materials  
(Cross-listed with AER E, M S E). (3-0) Cr. 3. Alt. S., offered even-numbered years. 
*Prereq: E M 324*  

E M 570: Wind Engineering  
(Cross-listed with AER E). (3-0) Cr. 3. Alt. S., offered odd-numbered years. 
*Prereq: E M 378, E M 345*  
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.

E M 590: Engineering Mechanics Special Topics  
Cr. 1-4. Repeatable. 
*Prereq: Permission of instructor*

E M 590F: Engineering Mechanics Special Topics: Introduction to Dislocation and Plasticity  
Cr. 1-4. Repeatable. 
*Prereq: Permission of instructor*

E M 590H: Engineering Mechanics Special Topics: Mechanics of Thin Films and Adhesives  
Cr. 1-4. Repeatable. 
*Prereq: Permission of instructor*

Cr. 1-4. Repeatable. 
*Prereq: Permission of instructor*

E M 590J: Engineering Mechanics Special Topics: Other  
Cr. 1-4. Repeatable. 
*Prereq: Permission of instructor*

E M 599: Creative Component  
Cr. arr. Repeatable.  

**Courses for graduate students:**  

E M 690: Engineering Mechanics Special Topics  
Cr. 1-6. Repeatable. 
*Prereq: Permission of instructor*

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

E M 690P: Engineering Mechanics Special Topics: Advanced Materials  
Cr. 1-6. Repeatable. 
*Prereq: Permission of instructor*

E M 690Q: Engineering Mechanics Special Topics: Advanced Computational Methods  
Cr. 1-6. Repeatable. 
*Prereq: Permission of instructor*

E M 690R: Engineering Mechanics Special Topics: Reliability and Failure  
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.