THEORETICAL AND APPL MECHANICS (TAM)

TAM Class Schedule (https://courses.illinois.edu/schedule/DEFAULT/DEFAULT/TAM)

Courses

TAM 195  Mechanics in the Modern World  credit: 1 Hour.
Freshman introduction to engineering mechanics and its role in modern engineering analysis and design. Project activity.

TAM 199  Undergraduate Open Seminar  credit: 1 to 5 Hours.
May be repeated.

TAM 201  Mechanics for Technol & Mgmt  credit: 3 Hours.
Engineering mechanics (statics, dynamics, solid mechanics, and fluid mechanics) and the role that mechanics plays in engineering analysis and design. For Technology and Management majors only.

TAM 210  Introduction to Statics  credit: 2 Hours.
Forces, moments, couples; resultant of force systems; equilibrium analysis and free-body diagrams; analysis of forces acting on members of trusses, frames, etc.; shear-force and bending-moment distributions; Coulomb friction; centroids and center of mass; applications of statics in design. Credit is not given for both TAM 210 and TAM 211. Prerequisite: PHYS 211; credit or concurrent registration in MATH 241.

TAM 211  Statics  credit: 3 Hours.
Forces, moments, and couples; resultant of force systems; equilibrium analysis and free-body diagrams; analysis of forces acting on members of trusses, frames, etc.; shear-force and bending-moment distributions; Coulomb friction; centroids, center of mass, moment of inertia, polar moment of inertia, and product of inertia; virtual work; hydrostatic pressure; applications of statics in design. Credit is not given for both TAM 211 and TAM 210. Prerequisite: PHYS 211; credit or concurrent registration in MATH 241.

TAM 212  Introductory Dynamics  credit: 3 Hours.
Kinematics and dynamics of the three-dimensional motion of particles; kinematics and dynamics of the plane motion of rigid bodies; methods of work energy and impulse momentum; moving reference frames. Prerequisite: TAM 210 or TAM 211.

TAM 251  Introductory Solid Mechanics  credit: 3 Hours.
Relationship between internal stresses and deformations produced by external forces acting on deformable bodies, and design principles based on mechanics of solids: normal stresses, shear stresses, and deformations produced by tensile, compressive, torsional, and bending loading of members; beam deflections; elastic energy and impact; multi-dimensional stress states; buckling of columns. Prerequisite: TAM 210 or TAM 211.

TAM 252  Solid Mechanics Design  credit: 1 Hour.
Design problems and projects intended to accompany TAM 251. Prerequisite: Credit or concurrent registration in TAM 251.

TAM 270  Design for Manufacturability  credit: 3 Hours.
Same as ME 270. See ME 270.

TAM 297  Introductory Independent Study  credit: 1 to 3 Hours.
Independent study and/or individual projects related to engineering mechanics. Approved for Letter and S/U grading. May be repeated to a maximum of 6 credit hours for letter grade; no limit for S/U grade mode. Prerequisite: Consent of Instructor.

TAM 302  Engineering Design Principles  credit: 3 Hours.
Examples of mechanical design problems that occur in engineering practice and the procedures and issues involved in solving them; technical aspects and societal ramifications of the design process; intellectual property, ethics, and contemporary issues; probability and statistics; computational mechanics; case studies; student discussion of design-related issues at different levels; design project reports and presentations; student teams.

TAM 324  Behavior of Materials  credit: 4 Hours.
Same as CEE 300. See CEE 300.

TAM 335  Introductory Fluid Mechanics  credit: 4 Hours.
Fluid statics; continuity, momentum, and energy principles via control volumes; ideal and real fluid flow; introduction to the Navier-Stokes equation; similitude; laminar and turbulent boundary layers; closed-conduit flow, open-channel flow, and turbomachinery. Prerequisite: TAM 212.

TAM 412  Intermediate Dynamics  credit: 4 Hours.
Lagrangian mechanics of dynamical systems with an emphasis on vibrations; constraints and generalized coordinates; motion in accelerating frames; conservation laws and invariance of the Lagrangian; particle motion in one dimension, the two-body problem, and central-force motion; free and forced vibration of linearized single-degree-of-freedom and multi-degree-of-freedom discrete systems; weakly nonlinear vibrations; parametric resonance; introduction to Hamiltonian dynamics; rigid-body motions. 4 undergraduate hours. 4 graduate hours. Credit is not given for both TAM 412 and AE 352. Prerequisite: MATH 225 or MATH 415; MATH 285; TAM 212.

TAM 413  Fund of Engrg Acoustics  credit: 3 or 4 Hours.
Same as ECE 473. See ECE 473.

TAM 416  Intro to Nonlinear Dyn & Vib  credit: 4 Hours.
Single- and multi-degree-of-freedom oscillators; asymptotic methods; forced, internal and combination resonances; time-discrete dynamical systems (maps); complex dynamics; parametric vibrations and resonances; introduction to nonlinear localization and nonlinear targeted energy transfer; nonlinear vibrations of elastic continua; application in mechanics and engineering. 4 undergraduate hours. 4 graduate hours. Prerequisites: MATH 285 OR MATH 441; MATH 415; TAM 212.

TAM 424  Mechanics of Structural Metals  credit: 3 Hours.
Micromechanisms at the atomic, single-crystal, and polycrystal levels and their use in explaining the deformation and failure characteristics of metals; elastic deformation, dislocation mechanics, plastic deformation and strengthening mechanisms, fracture mechanics and fracture mechanisms, fatigue, and creep; design criteria; special topics. 3 undergraduate hours. 3 graduate hours. Prerequisite: CEE 300 or ME 330.

TAM 427  Mechanics of Polymers  credit: 3 Hours.
Mechanical behavior of amorphous and semi-crystalline polymers; overview of polymer structure, properties, and processing; polymer linear viscoelasticity using Boltzmann superposition and mechanical models; measurement of viscoelastic properties; polymeric yield phenomena; fracture and craze formation; impact and fatigue. Same as AE 427 and MSE 454. 3 undergraduate hours. 3 graduate hours. Prerequisite: CEE 300 or ME 330.

TAM 428  Mechanics of Composites  credit: 3 Hours.
Same as AE 428 and MSE 456. See MSE 456.
TAM 435  Intermediate Fluid Mechanics  credit: 4 Hours.
Analytical solution methods for problems involving ideal and real fluids: potential flow theory, boundary-layer theory; surface waves, vortex dynamics, and compressible flows. 4 undergraduate hours. 4 graduate hours. Prerequisite: One of AE 312, ME 310, TAM 335.

TAM 445  Continuum Mechanics  credit: 4 Hours.
Tensor algebra and analysis; kinematics of continua; mass, force, stress, and the general balance laws of continuum mechanics; introduction to constitutive equations. 4 undergraduate hours. 4 graduate hours. Prerequisite: TAM 251.

TAM 451  Intermediate Solid Mechanics  credit: 4 Hours.
Analysis of stress and strain (definitions, transformation of axes, equilibrium equations, and symmetry of the stress tensor); linear materials, Hooke's law; strain energy, potential energy, energy principles and methods; two-dimensional problems in elasticity (torsion, axisymmetric problems); the finite-element method for two- and three-dimensional boundary-value problems in linear elasticity; plasticity (introduction, yield criteria, elastic-plastic behavior, and limit- load calculations); linear-elastic fracture mechanics (introduction, Griffith's approach, stress intensity factor, and energy release rate). 4 undergraduate hours. 4 graduate hours. Prerequisite: TAM 251.

TAM 456  Experimental Stress Analysis  credit: 3 Hours.
Basic theories for measuring stresses and deformations in load-carrying engineering components; use of optical, electrical, and mechanical instrumentation; laboratory sessions on brittle coatings, electrical resistance strain gages, photoelasticity, and moire interferometry. 3 undergraduate hours. 3 graduate hours. Prerequisite: TAM 251.

TAM 461  Cellular Biomechanics  credit: 4 Hours.
Mechanics of biological cells and tissues: cell structure; mechanics of biomembranes; the cytoskeleton and cortex; dynamic cell processes; cell motility and control of cell shape and proliferation; experimental approaches and theoretical models. Same as BIOE 461. 4 undergraduate hours. 4 graduate hours. Prerequisite: TAM 251.

TAM 470  Computational Mechanics  credit: 3 or 4 Hours.
Modern computational mechanics: mappings and iterative methods; stability; convergence; consistency; numerical and symbolic solutions of ordinary and partial differential equations; finite-difference methods; the finite-element method; spectral methods. Applications to problems in solid mechanics, fluid mechanics, and dynamics. Same as CSE 450. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 101 and MATH 285.

TAM 497  Independent Study  credit: 1 to 3 Hours.
Individual studies in any area of theoretical and applied mechanics. 1 to 3 undergraduate hours. No graduate credit. May be repeated to a maximum of 6 hours in separate terms as topics vary. Prerequisite: Consent of Instructor. Students with Junior or Senior standing.

TAM 498  Special Topics  credit: 1 to 4 Hours.
Subject offerings of new and developing areas of knowledge in theoretical and applied mechanics intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. 1 to 4 undergraduate hours. 1 to 4 graduate hours. May be repeated in the same or separate terms if topics vary to a maximum of 9 undergraduate hours or 12 graduate hours.

TAM 499  Senior Thesis  credit: 3 Hours.
Thesis investigation of special subjects in mechanics, including theoretical or experimental research. 3 undergraduate hours. No graduate credit. Prerequisite: Department and instructor approval required.

TAM 500  Seminar  credit: 1 Hour.
Lectures and discussion on current topics in theoretical and applied mechanics. Approved for S/U grading only.

TAM 514  Elastodynamics and Vibrations  credit: 4 Hours.
Review of theory of multi-degree-of-freedom systems; problems in the free and forced vibration of continuous linear elastic structures, rods, beams, membranes, plates, and three-dimensional solid and fluid bodies; Lagrangian densities, Sturm-Liouville problems, time and frequency domains, damping, Green's functions, and elastic waves; propagation and modal analysis; modeling of damping in structures; response of complex structures. Same as AE 551. 4 graduate hours. No professional credit. Prerequisite: TAM 412, TAM 542, and TAM 551.

TAM 518  Wave Motion  credit: 4 Hours.
Linear waves in one-dimensional homogeneous and inhomogeneous media (both solids and fluids), linear elastic waves in a homogeneous halfspace, scalar waves in a layer and in a layered halfspace, nonlinear diffusive waves, nonlinear dispersive waves, and the inverse scattering transform. Prerequisite: TAM 541 or MATH 556; one of TAM 514, TAM 531, TAM 551.

TAM 524  Micromechanics of Materials  credit: 4 Hours.
Advanced analysis of modern engineering materials with emphasis on relating microstructural phenomena to the mechanics of material behavior; prediction of elastic and thermal properties of materials with heterogeneous microstructure (such as composites), micromechanics of failure and damage, toughening mechanisms, mechanics of phase transformations; current topics in materials research (such as high-temperature response and ferroelasticity). Prerequisite: CEE 300 or ME 330, TAM 551.

TAM 529  Viscoelasticity Theory  credit: 4 Hours.
Same as AE 529. See AE 529.

TAM 531  Inviscid Flow  credit: 4 Hours.
Dynamics of fluids in the limit of zero viscosity: governing equations of motion, kinematics, and vorticity transport; general theory of irrotational flow, including two-dimensional potential flow, the complex potential, and three-dimensional potential flow; applications to thin airfoil theory and free streamline theory; inviscid flows with vorticity; vortex dynamics; water wave theory; aspects of inviscid compressible flow. Prerequisite: MATH 285 and TAM 435.

TAM 532  Viscous Flow  credit: 4 Hours.
Dynamics of flow in which viscosity is significant or dominant, and the development and use of theoretical and numerical tools for practitioners of modern fluid mechanics; physics of viscous layers that arise in both high- and low-Reynolds-number flows; dimensional analysis, exact solutions to the Navier-Stokes equations; jets and wakes; microhydrodynamics; fluid stability; turbulence. Prerequisite: MATH 285 and TAM 435.

TAM 536  Instability and Transition  credit: 4 Hours.
Stability of fluid motion: linearized flow equations and normal-mode analysis, Kelvin-Helmholtz instability, inviscid and viscous theory of parallel shear flow, Squire's and Rayleigh's inflection-point theorems, secondary instability theory; critical layers; boundary-layer stability; Orr-Sommerfeld equations, Tollmien-Schlichting waves; non-parallel theory, centrifugal instabilities, and Benard convection; nonlinear theory and transition to turbulence; bifurcations, Landau's theory; routes to chaos, strange attractors; transition modeling, prediction, and control; boundary-layer receptivity, experimental evidence. Prerequisite: TAM 532.

Information listed in this catalog is current as of 04/2018
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAM 537</td>
<td>Experimental Fluid Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>TAM 538</td>
<td>Turbulence</td>
<td>4</td>
</tr>
<tr>
<td>TAM 539</td>
<td>Fluid Mechanics Seminar</td>
<td>1</td>
</tr>
<tr>
<td>TAM 541</td>
<td>Mathematical Methods I</td>
<td>4</td>
</tr>
<tr>
<td>TAM 542</td>
<td>Mathematical Methods II</td>
<td>4</td>
</tr>
<tr>
<td>TAM 545</td>
<td>Advanced Continuum Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>TAM 549</td>
<td>Asymptotic Methods</td>
<td>4</td>
</tr>
<tr>
<td>TAM 551</td>
<td>Solid Mechanics I</td>
<td>4</td>
</tr>
<tr>
<td>TAM 552</td>
<td>Solid Mechanics II</td>
<td>4</td>
</tr>
<tr>
<td>TAM 553</td>
<td>Fluid Mechanics</td>
<td>4</td>
</tr>
</tbody>
</table>

TAM 537 Experimental Fluid Mechanics  credit: 4 Hours.
Methods and techniques for measurement and analysis of data used in experimental fluid mechanics: signal processing, electronics, and electrophysics; fluid mechanical properties; experimental signal processing; random data and signal analysis; analog and digital data processing; dynamic similarity, self-preservation; pressure measurement, thermal anemometry, and laser-Doppler velocimetry; flow visualization, particle-image velocimetry. Prerequisite: TAM 531 or TAM 532.

TAM 538 Turbulence  credit: 4 Hours.
Instability and origins of chaotic motion in fluid flow; Reynolds averaging and statistical description of turbulence, correlations and spectral dynamics of homogeneous turbulence, anisotropic flows, coherent structures, inhomogeneous turbulence, transport models, and large-eddy simulations. Prerequisite: TAM 532.

TAM 539 Fluid Mechanics Seminar  credit: 1 Hour.
Weekly seminar on current research topics in turbulent and other complex flows: theoretical modeling, numerical analysis, computational techniques, and experimental investigations. Approved for S/U grading only.

TAM 541 Mathematical Methods I  credit: 4 Hours.
Vector and tensor algebra and complex-variable methods; ordinary differential equations, qualitative questions of existence and uniqueness; analytic solution methods, numerical methods, power-series solution and special functions; eigenvalue problems, Green's functions, Laplace transforms, stability of solutions; engineering applications drawn from mechanics. Prerequisite: MATH 285 and TAM 251.

TAM 542 Mathematical Methods II  credit: 4 Hours.
Continuation of TAM 541. Modeling, inequalities, elements of functional analysis; partial differential equations, existence and uniqueness, second-order equations; hyperbolic conservation laws; numerical methods, eigenfunction expansions, integral transforms, and fundamental solutions; engineering applications drawn from mechanics. Prerequisite: TAM 541.

TAM 545 Advanced Continuum Mechanics  credit: 4 Hours.
Unified treatment of modern continuum mechanics: mathematical preliminaries; review of kinematics and general balance laws; general theory of mechanical constitutive equations, including material constraints and material symmetry. Prerequisite: TAM 551.

TAM 549 Asymptotic Methods  credit: 4 Hours.
Advanced methods of perturbation theory and asymptotic analysis, with examples drawn from classical dynamics, fluid mechanics, and wave propagation: asymptotics of integrals, singular perturbation theory (boundary layers, matched asymptotic expansions, and composite expansions), multiple scales, summation of series; special topics. Prerequisite: MATH 446 and TAM 541.

TAM 551 Solid Mechanics I  credit: 4 Hours.
Mechanics of elastic deformable bodies, based on the fundamental concepts of modern continuum mechanics: kinematics, balance laws, constitutive equations; classical small-deformation theory; formulation of initial boundary-value problems of linear elastodynamics and boundary-value problems of linear elastostatics; variational formulations, minimum principles; applications of theory to engineering problems. Prerequisite: MATH 285.

TAM 552 Solid Mechanics II  credit: 4 Hours.
Continuation of TAM 551. Selected topics in linear elasticity (including St. Venant beam theory and plane problems of elastostatics), plasticity (including yield surfaces, von Mises and Tresca yield criteria, Drucker’s stability postulate, J-flow theory, perfect plasticity, limit analysis, and slip-line theory), and fracture mechanics (including linear elastic analysis, fracture criteria for elastic brittle fracture, and elastic-plastic fracture). Prerequisite: TAM 551.

TAM 553 Fluid Mechanics  credit: 4 Hours.
Phenomenological and mathematical formulation of the constitutive laws of plasticity; yield criteria and their experimental verification; plastic stress-strain relations and their associated flow rules; correspondence between rate-independent and rate-dependent plasticity; solutions to basic boundary-value problems, including plane problems and those involving cylindrical and spherical symmetries; variational and minimum principles; limit analysis; plane-strain problems and crystal plasticity; finite-strain theory. Prerequisite: TAM 552.

TAM 554 Plasticity  credit: 4 Hours.
Unified analytical treatment of modern fracture problems: macroscopic theories used to determine the static strength of bodies containing cracks; Griffith criterion, linear-elastic fracture mechanics, elastic-plastic fracture mechanics models; small-scale yielding results and their implications; general yielding; interfacial fracture; fracture control; micromechanisms of fracture. Prerequisite: TAM 424 or MSE 440; TAM 541; TAM 552.

TAM 555 Fracture Mechanics  credit: 4 Hours.
Continuation of TAM 554. Selected topics in linear elasticity (including yield surfaces, von Mises and Tresca yield criteria, Drucker’s stability postulate, J-flow theory, perfect plasticity, limit analysis, and slip-line theory), and fracture mechanics (including linear elastic analysis, fracture criteria for elastic brittle fracture, and elastic-plastic fracture). Prerequisite: TAM 551.

TAM 556 Geometric and Rigidity Percolation  credit: 4 Hours.
Unified treatment of modern fracture problems: macroscopic theories used to determine the static strength of bodies containing cracks; Griffith criterion, linear-elastic fracture mechanics, elastic-plastic fracture mechanics models; small-scale yielding results and their implications; general yielding; interfacial fracture; fracture control; micromechanisms of fracture. Prerequisite: TAM 424 or MSE 440; TAM 541; TAM 552.

TAM 557 Mechanics of Random Media  credit: 4 Hours.
Methods to study mechanics of complex/random microstructures involving several scales: random geometry and stochastic processes and fields, including spatial point processes, mathematical morphology, geodesics, ergodicity, entropy, (non)stationary and (an)isotropic tensor random fields for fluids (turbulence) and solids (microstructures), representations and spectra; truss- and beam-lattices and corresponding (non-)classical continua for modeling crystals, cellular media (e.g., metallic foams), and granular matter; geometric and rigidity percolation; plasticity, fracture, slip statistics, and fractals in disordered media; scaling to Representative Volume Element (RVE) in conductivity, (non)linear elasticity, elasto-plasticity, flow in porous media, and coupled field phenomena; statistical continuum theories for problems without RVE (i.e., lacking separation of scales); stochastic finite elements; effects of microscale randomness on waves and wavefronts in (non)linear elastic/dissipative solid or fluid media; fractional calculus and mechanics of fractal media. Prerequisite: TAM 445 or TAM 551; MATH 362.

TAM 570 Computational Fluid Mechanics  credit: 4 Hours.
Highly accurate and reliable techniques for large-scale numerical simulations of fluid flows: spectral numerical methods, including Fourier and other functional expansions, Galerkin and collocation projections, domain decompositions and the solution of partial differential equations, especially the Navier-Stokes equations; high-resolution methods for the solution of hyperbolic conservation laws with discontinuous solutions, and issues related to implementation on supercomputers. Same as CSE 560. Prerequisite: TAM 470 and TAM 542.

TAM 574 Adv Finite Element Methods  credit: 4 Hours.
Advanced theory and applications of the finite-element method, as needed for research in computational science and engineering: applications to mechanics of solids and fluids, thermal problems, etc.; variational foundations of the finite-element method, error estimates, and adaptive analysis; finite-element methods for parabolic and hyperbolic problems; mixed finite-element methods; applications to systems of equations. Same as CSE 517. Prerequisite: One of TAM 470, CEE 570, CS 555, ME 471.
TAM 597  Advanced Independent Study  credit: 1 to 8 Hours.
Analytical, experimental, or computational studies in one or more areas of theoretical and applied mechanics, including solid mechanics, behavior of materials, fluid mechanics, dynamics, applied mathematics, and computational science and engineering. May be repeated. (Summer session, 1 to 4 hours). Prerequisite: Consent of instructor.

TAM 598  Advanced Special Topics  credit: 1 to 4 Hours.
Subject offerings of new and developing areas of knowledge in theoretical and applied mechanics intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. May be repeated in the same or separate terms if topics vary to a maximum of 12 hours.

TAM 599  Thesis Research  credit: 0 to 16 Hours.
Approved for S/U grading only. May be repeated.