AE - AEROSPACE ENGINEERING

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

Courses

AE 100 Intro to Aerospace Engineering credit: 2 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/100/**)**
Introduction to the Aerospace Engineering curriculum and career. Typical section topics include aircraft and rocket design and flight. Overviews of the topics are presented along with theory to be experimentally verified.

AE 140 Aerospace Computer-Aided Design credit: 2 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/140/**)**
Computer-aided design (CAD) software modeling of engineered components. Sketching and three-dimensional solid modeling. Complex surface modeling. Production of assembly drawings and exploded views. Creation of dimensioned drawings using best practices for manufacturing. Sketching of parts in isometric views and multi-view drawings along with spatial visualization. Aerospace engineering-themed final project. Credit is not given for AE 140 and either SE 101 or ME 170. Prerequisite: Restricted to Aerospace Majors.

AE 199 Undergraduate Open Seminar credit: 0 to 5 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/199/**)**
Undergraduate Open Seminar. Approved for Letter and S/U grading. May be repeated.

AE 202 Aerospace Flight Mechanics credit: 3 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/202/**)**
Fundamental principles of aerospace flight mechanics applied to spacecraft and aircraft. Orbital mechanics, rocket propulsion, and dynamics and control applied to spacecraft design. Aerodynamics, maneuvering, stability and flight performance applied to aircraft design. Prerequisite: Credit or concurrent registration in TAM 212.

AE 298 Special Topics credit: 1 to 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/298/**)**
Lectures and discussions relating to new areas of interest. See class schedule for topics and prerequisites. May be repeated if topics vary.

AE 302 Aerospace Flight Mechanics II credit: 3 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/302/**)**
Fundamentals of aircraft and spacecraft dynamics and orbital mechanics; aircraft performance in various flight attitudes; aircraft stability and control; spacecraft attitude dynamics and control; the two-body problem of orbital mechanics; orbit transfer. Prerequisite: AE 352.

AE 311 Incompressible Flow credit: 3 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/311/**)**
Equations of motion for incompressible flow, both inviscid and viscous; potential flow theory, inviscid airfoil theory: two- and three-dimensional, Navier-Stokes equations, laminar boundary layer and transition to turbulence. Prerequisite: Credit or concurrent registration in AE 202 and MATH 241.

AE 312 Compressible Flow credit: 3 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/312/**)**
Dynamics of compressible fluid; conservation of mass, momentum, and energy; one-dimensional and quasi-one-dimensional flow; oblique shock waves & Parandtl-Meyer expansion fans; unsteady wave motion; linearized theory. Application to nozzles, diffusers, airfoils, shock tubes and other geometries. Prerequisite: AE 202 and MATH 285. Credit or concurrent registration in ME 200.

AE 321 Mechs of Aerospace Structures credit: 3 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/321/**)**
Fundamental concepts in the linear theory of elasticity, including stress, strain, equilibrium, compatibility, material constitution and properties. Failure mechanisms and criteria. Application to plane stress-strain problems, beams in extension and bending, and shafts in torsion. Prerequisite: MATH 285 and one of TAM 210 or TAM 211.

AE 323 Applied Aerospace Structures credit: 3 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/323/**)**
Fundamental concepts of stress, strain, equilibrium, compatibility, material constitution and properties. Analysis of beams and shafts of monocoque and semi-monocoque construction. Energy methods. Prerequisite: AE 321, MATH 241, MATH 285, and one of TAM 210 or TAM 211.

AE 352 Aerospace Dynamical Systems credit: 3 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/352/**)**
Particle kinematics and dynamics; Lagrange's equations; vibration of multiple degree-of-freedom systems; rotational kinematics and dynamics of rigid bodies. Credit is not given toward graduation for both AE 352 and TAM 412. Prerequisite: MATH 225, MATH 257, or MATH 415; MATH 285, MATH 284, MATH 286, or MATH 441; and TAM 212.

AE 353 Aerospace Control Systems credit: 3 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/353/**)**
Modeling of linear dynamic systems; Laplace transform techniques; linear feedback control systems; stability criteria; design techniques. Credit is not given toward graduation for AE 353 and either SE 320 or ME 340. Prerequisite: MATH 225, MATH 257, or MATH 415; and MATH 285 and TAM 212.

AE 370 Aerospace Numerical Methods credit: 3 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/370/**)**
Numerical methods used in aerospace engineering. Numerical integration, curve fitting, root finding, numerical solution of ODE, solution of linear systems of equations. Finite difference. Rayleigh-Ritz, and Finite element methods. Applications to simple structural mechanics and aerodynamics problems encountered in aerospace engineering. Prerequisite: Credit or concurrent registration in AE 311 or AE 312; credit or concurrent registration in AE 321 or AE 323.

AE 395 Honors Project credit: 1 to 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/395/**)**
Special aerospace engineering project or reading course for James Scholars in engineering. Prerequisite: Consent of instructor.

AE 396 Honors Seminar credit: 1 to 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/396/**)**
Special lecture sequences or discussion groups arranged each term to bring James Scholars in engineering into direct contact with the various aspects of engineering practices and philosophy. Prerequisite: Consent of instructor.

AE 397 Independent Study credit: 1 to 3 Hours. (https://courses.illinois.edu/schedule/terms/AE/397/)
Independent theoretical and experimental projects in aerospace engineering. May be repeated. Prerequisite: Consent of instructor.

AE 398 Special Topics credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/398/)
Lectures and discussions relating to new areas of interest. See class schedule for topics and prerequisites. May be repeated if topics vary.

AE 402 Orbital Mechanics credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/402/)
Analysis of orbits in an inverse-square gravitational field; elementary rocket dynamics, impulsive orbit transfer and rendezvous, and Lambert's Theorem with applications; patched-conic trajectories, planetary gravity-assist maneuvers, and linearized orbit theory with application to simplified analytical models; perturbations. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 202.

AE 403 Spacecraft Attitude Control credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/403/)
Theory and applications of spacecraft attitude dynamics and control; Euler angles, direction cosines, quaternions, and Gibbs-Rodrigues parameters; attitude sensors and control actuators; spin, three-axis active, reaction wheel, control moment gyro, and gravity gradient control systems; environmental effects. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 352 and AE 353.

AE 410 Computational Aerodynamics credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/410/)
Computational technologies as solution tools for various aerodynamic problems; modeling and solution of one-and two-dimensional, incompressible and compressible, steady and unsteady inviscid external flow fields. Computational laboratory for practical experience. Same as CSE 461. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 311; credit or concurrent enrollment in AE 312.

AE 412 Viscous Flow & Heat Transfer credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/412/)
Momentum and thermal transport in wall boundary-layer and free shear flows, solutions to the Navier-Stokes equations for heat conducting laminar and turbulent shear flows; similarity concepts; thermal boundary layers in ducts and high-speed aerodynamic boundary layers. Same as ME 411. 4 undergraduate hours. 4 graduate hours. Prerequisite: AE 311, ME 310 or TAM 335.

AE 416 Applied Aerodynamics credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/416/)
Two-dimensional and finite wing theory with emphasis on the mechanisms of lift and drag generation; Reynolds number and Mach number effects; drag analysis; high-lift wing systems; propeller and rotor aerodynamics; control surface design; application of V/STOL aerodynamics. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 311.

AE 419 Aircraft Flight Mechanics credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/419/)
Steady and quasi-steady aircraft flight performance; take-off and landing, climbing and diving, cruise, level turn, and energy methods; longitudinal, directional, and lateral static stability and control; longitudinal and lateral motion and dynamic stability. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 202 and AE 353.

AE 420 Finite Element Analysis credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/420/)
Same as CSE 451 and ME 471. See ME 471.

AE 428 Mechanics of Composites credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/AE/428/)
Same as MSE 456 and TAM 428. See MSE 456.

AE 433 Aerospace Propulsion credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/433/)
Fundamentals of rocket and airbreathing jet propulsion devices electric propulsion; prediction of thrust, combustion reactions, specific fuel consumption, and operating performance; ramjets; turbojets; turbofans; turboprops; aerothermodynamics of inlets, combustors, and nozzles; compressors, turbines; component matching, fundamentals of electrothermal, electromagnetic elastostatis thrusters, and solar sails. 3 undergraduate hours. 4 graduate hours. Prerequisite: AE 312 and PHYS 212.

AE 434 Rocket Propulsion credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/434/)
Basic principles of chemical rocket propulsion and performance, rocket component design, liquid rockets, solid rocket motors, combustion processes, combustion instability. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 312.

AE 435 Electric Space Propulsion credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/435/)
Elements of electric propulsion as applied to near-earth and deep-space missions; impact on spacecraft design; physics of ionized gases; plasmadynamics; electrothermal, electromagnetic, and electrostatic acceleration of gases to high velocity; high-impulse thruster design and performance; the resistojet, arcjet, ion engine, Hall thruster, MPD arc thruster, and plasma gun. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 312 or ME 410, PHYS 212, and ECE 205.

AE 442 Aerospace Systems Design I credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/AE/442/)
Principles of systems engineering as they apply to the design process for aerospace flight systems; general design methodology; application of these concepts to the initial sizing of both aircraft and spacecraft systems. Intensive technical writing. 3 undergraduate hours. No graduate credit. AE 442 and AE 443 taken in sequence fulfill the Advanced Composition Requirement. Prerequisite: Credit or concurrent registration in AE 311, AE 323, and AE 352.

AE 443 Aerospace Systems Design II credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/AE/443/)
Continuation of AE 442. Conceptual design project of either an aircraft or spacecraft flight system to satisfy a given set of requirements. Project team organization. Emphasis on sizing, trade studies and design optimization, subsystem integration, and technical communication skills. 3 undergraduate hours. No graduate credit. To fulfill the Advanced Composition Requirement, credit must be earned for both AE 442 and AE 443. Prerequisite: AE 442.
This course satisfies the General Education Criteria for:
Advanced Composition

AE 451 Aeroelasticity credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/451/)
In-depth examination of aerodynamic and dynamic structural phenomena associated with flexible airplanes and missiles; divergence of linear and nonlinear elastic lifting surfaces; effect of elastic and inelastic deformations on lift distributions and stability; elastic flutter of straight and swept wings; equations of disturbed motion of elastic and inelastic aircraft; dynamic response to forces, gusts, and continuous atmospheric turbulence; creep divergence of lifting surfaces; flutter in the presence of creep; effect of temperature on inelastic divergence and flutter. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 352 or TAM 412; TAM 251.

AE 452 Introduction to Nonlinear Dynamics and Vibrations credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/452/)
Same as TAM 416. See TAM 416.

AE 454 Systems Dynamics & Control credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/454/)
Examination of the common core of dynamics and control theory. Fundamental concepts of Lagrangian dynamics, state space representations, Hamiltonian and modern dynamics, stability theory, and control of dynamical systems. 3 undergraduate hours. 4 graduate hours. Prerequisite: AE 353.

AE 456 Global Nav Satellite Systems credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/456/)
Same as ECE 456. See ECE 456.

AE 460 Aerodynamics & Propulsion Lab credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/AE/460/)
Theory and application of experimental techniques in aerospace engineering with emphasis on fluid dynamic, aerodynamic, thermal, combustion, and propulsion phenomena. 2 undergraduate hours. No graduate credit. Prerequisite: AE 311; credit or concurrent registration in AE 433.

AE 461 Structures & Control Lab credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/AE/461/)
Theory and application of experimental techniques in aerospace engineering with emphasis on structural mechanics, vibrations, dynamics, and control systems. 2 undergraduate hours. No graduate credit. Prerequisite: AE 321 and AE 352. Credit or concurrent registration in AE 323 and AE 353.

AE 468 Optical Remote Sensing credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/AE/468/)
Same as ECE 468. See ECE 468.

AE 480 Hypersonic Aerothermodynamics credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/480/)
Fundamental aspects of hypersonic flows and aerothermodynamics of high-speed vehicles; the hypersonic aerothermal environment; inviscid hypersonic flows; hypersonic boundary layers; basics of high temperature gas dynamics and thermochemical nonequilibrium flows; re-entry aeromechanics 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 312.

AE 482 Introduction to Robotics credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/482/)
Same as ECE 470 and ME 445. See ECE 470.

AE 483 Autonomous Systems Lab credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/AE/483/)
Theory and application of experimental techniques in aerospace engineering with emphasis on autonomous systems. 2 undergraduate hours. No graduate credit. Prerequisite: AE 202, AE 352, AE 353, AE 370, and PHYS 212.

AE 484 UAV Performance, Design, and Fabrication credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/AE/484/)
This course will cover topics necessary to design, fabricate, and evaluate the performance of unmanned aerial vehicles (UAVs). After a brief introduction to UAVs, an overview will be given of aerodynamics, stability/control, propulsion, aircraft performance, UAV hardware, manufacturing methods, and computational tools needed to fabricate unmanned aerial vehicles. An emphasis of the course will be on aircraft fabrication techniques (welding, composites, turning, milling, joining, additive manufacturing, etc.) culminating in the construction of the final design project. 3 undergraduate hours. No graduate credit. Prerequisite: AE 202 and AE 311. Restricted to AE majors only.

AE 485 Spacecraft Environment and Interactions credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/485/)
The course focuses on the theoretical and practical aspects of spacecraft aerodynamics and environment. It covers topics related to free molecular flows. Materials interactions and onboard sensor optical backgrounds caused by spacecraft neutral interactions, chemical reactions of materials with ambient atomic O, spacecraft glow, ion and chemical thrusters are studied. The plasma space environment, its connection to our sun, and the presence of the van Allen Belts and their affect on spacecraft charging for LEO and GEO conditions are discussed. Spacecraft shielding requirements due to plasma interactions and the space radiation environment are examined. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 311, AE 312, ME 200.

AE 497 Independent Study credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/497/)
Independent theoretical and experimental projects in aerospace engineering. 1 to 4 undergraduate hours. 1 to 4 graduate hours. May be repeated. Prerequisite: Consent of instructor.

AE 498 Special Topics credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/498/)
Subject offerings of new and developing areas of knowledge in aerospace engineering intended to augment the existing curriculum. See Class Schedule or department course information for topics and prerequisite. 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.

AE 502 Advanced Orbital Mechanics credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/502/)
Circular-restricted three-body problem; surfaces of zero velocity, libration points, and halo orbits; perturbed two-body motion; Gauss and Lagrange planetary equations, Hamilton's principle, canonical equations and Delaunay variables; application to artificial Earth satellites; orbit determination. Prerequisite: AE 402.

AE 504 Optimal Aerospace Systems credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/504/)
Formulation of parameter and functional optimization problems for dynamic systems; applications of optimization principles to the control and performance of aerospace vehicles, including optimal flight paths, trajectories, and feedback control. Prerequisite: AE 352.

AE 508 Optimal Space Trajectories credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/508/**)**
Optimal rocket trajectories in inverse-square and linearized gravitational fields; orbital transfer, intercept, and rendezvous; high-thrust (impulsive) and low-thrust (continuous) trajectories; primer vector theory and applications; cooperative rendezvous. Prerequisite: Credit or concurrent registration in AE 504.

AE 510 Advanced Gas Dynamics credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/510/**)**
Same as ME 510. See ME 510.

AE 511 Transonic Aerodynamics credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/511/**)**
Fundamentals of transonic flows; transonic characteristics and flow modeling, shock wave development, properties of shock wave, transonic similarity, shock-boundary layer interactions, three-dimensional effects, transonic solution techniques, transonic design, and transonic testing. Prerequisite: ME 410.

AE 512 Molecular Gas Dynamics credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/512/**)**
The course focuses on the molecular description of physical and chemical processes in gases. The molecular viewpoint is essential to promote the understanding of physical processes occurring at very high temperatures and low pressures. These conditions are typically encountered in high speed and non-equilibrium gas flows. After a brief review of the fundamental concepts of statistical mechanics and chemical thermodynamics, the course focuses on the fundamentals of kinetic theory of gases, equilibrium chemistry, non-equilibrium kinetics and non-thermal radiation. 4 graduate hours. No professional credit. Prerequisite: AE 311, AE 312, ME 200.

AE 514 Boundary Layer Theory credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/514/**)**
Boundary layer concept at high Reynolds numbers; self-similar solutions of incompressible and compressible boundary layers; stability of parallel and nearly-parallel wall-bounded viscous flows; transition to turbulence; turbulent boundary layers; high-speed boundary layers; strong Reynolds analogy; Morkovin's hypothesis. Prerequisite: AE 412.

AE 515 Wing Theory credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/515/**)**
Theoretical analysis of the aerodynamic characteristics of two- and three-dimensional wings and multiple-body systems in subsonic and supersonic flows. Prerequisite: AE 416.

AE 521 Fracture and Fatigue credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/521/**)**
Same as CEE 575. See CEE 575.

AE 522 Dynamic Response of Materials credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/522/**)**
One-dimensional stress waves; three-dimensional longitudinal and shear waves, reflection and refraction of plane waves; Rayleigh and Love waves; wave guides; spherical waves, inelastic wave propagation and shock waves; dynamic fracture and shear bandings of solids; wave propagation in anisotropic media; experimental techniques; acoustic emission, ultrasounds, split Hopkinson (Kolsky) bar, plate impact experiments, optical techniques in dynamic fracture, and high-speed photography. Prerequisite: TAM 451 or TAM 551.

AE 523 Nanoscale Contact Mechanics credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/523/**)**
Short- and long-range dipole and electronic interactions; particle- and surface-force interactions; contact mechanics of rigid and nonrigid media; continuum adhesion models; principles of Atomic Force Microscopy (AFM); artifacts and remedies in AFM imaging; force and scale calibration; dynamics of AC-AFM imaging; force spectroscopy; instrumented nanoindentation. Prerequisite: TAM 451 or TAM 551.

AE 524 Nonlinear Solid Mech Design credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/524/**)**
Same as ME 570. See ME 570.

AE 525 Advanced Composite Materials credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/525/**)**
An extension of TAM 428. Advanced analysis of composite materials. Anisotropic elasticity; micromechanical theories; behavior of composite plates and beams under bending, buckling, and vibration; advanced elasticity solution techniques; hygrothermal behavior of polymer composites; strength prediction theories and failure mechanisms in composites; processing of metal, ceramic, and polymer composites; analysis of residual stresses. Prerequisite: TAM 428.

AE 526 Composites Manufacturing credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/526/**)**
Manufacturing methods for polymer-matrix composite materials; analysis of fiber processing techniques, interfacial treatments, and composites fabrication methods; analytical treatment of process modeling including heat transfer, cure kinetics, resin flow, and residual stresses. Term project. Prerequisite: TAM 428.

AE 527 Multi-Scale Modeling of Materials credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/527/**)**
This course introduces the theoretical foundation of multi-scale methods, and provides students with hands-on modeling and simulation experience. Students will be introduced to a variety of modeling techniques covering the full spectrum of length-scales from atomistics to continuum. The emphasis will be in the use of continuum-based concepts, such as the Principle of Virtual Work and conservation integrals, as bridging techniques to link atomistics and the continuum. The goal is to enable interpretation of material phenomena across different length-scales. 4 graduate hours. No professional credit. Prerequisite: TAM 451, AE 420, and CSE 401, or equivalent.

AE 528 Nonlinear Continuous Media credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/528/**)**
Fundamental concepts of large deformations in nonlinear elasticity and inelasticity with applications: generalized tensors, finite deformations, stress-strain relations in terms of strain energy functions, inverse problems, solutions of tension, shear and bending problems, finite plane strain, theory of successive approximations, fiber-reinforced beams, plates and cylinders, thermodynamics of deformable media, stability considerations, and constituent relations for inelasticity. Prerequisite: AE 321 or TAM 451.

AE 529 Viscoelasticity Theory credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/529/**)**
Fundamental concepts of viscoelasticity with applications: elastic-viscoelastic analogies, creep and relaxation functions, Poisson's ratio, thermomechanical reciprocity relations, variational principles, model fitting, shear center motion, thick-walled cylinders under pressure and inertia loads with material annihilation, sandwich plates, propagation of viscoelastic waves, vibration of bars, plates and shells, nonlinear elastic-viscoelastic analogy, properties of nonlinear viscoelastic stress-strain laws, creep rupture, and torsion of nonlinear bars and shells. Same as TAM 529. Prerequisite: AE 321 or TAM 451.

AE 538 Combustion Fundamentals credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/538/**)**
Same as ME 501. See ME 501.

AE 542 Aerospace Syst Engineering I credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/542/**)**
Aerospace systems engineering principles, processes and practices for the definition of spacecraft, aircraft, launch and associated systems, and the application of the systems approach across the development life cycle. Prerequisite: Any of AE 442, AE 443, ME 470, ECE 445, ECE 411; CS 492, CS 493, or CEE 465.

AE 543 Aerospace Syst Engineering II credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/543/**)**
Fundamental aerospace industry methods for control of an engineering development effort of a complex aerospace system typical in development of spacecraft, launch vehicles, aircraft, remotely controlled vehicles, and associated supporting infrastructure system in current acquisition environments. Standards and techniques to control risk, integration of technologies, and exploration of "design-to" process tailoring and systematically make design decisions. Prerequisite: AE 542.

AE 550 Nonlinear Aeroelasticity credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/550/**)**
Integrated fundamental treatment of the physical and mathematical aspects of nonlinear aeroelasticity. Fluid-solid interactions of unsteady aerodynamics and flexible structures and their components with applications to air-space-land vehicles, wind mills, solar sails, and gossamer structures. Physical and mathematical modeling; solution protocols to nonlinear problems; self-excited nonlinear oscillators; torsional divergence, loss of stability and control due to structural flexibility; chordwise and un-symmetric bending; viscous and structural damping, motion control; straight and swept-wind flutter; stall divergence and flutter; panel flutter; aerodynamic noise; chaotic motion; gust loads; limit cycles. Prerequisite: AE 451.

AE 551 Elastodynamics and Vibrations credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/551/**)**
Same as TAM 514. See TAM 514.

AE 554 Dynamical Systems Theory credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/554/**)**
This course is structured to introduce the graduate students into advanced concepts of the geometric theory of nonlinear dynamics. Topics to be discussed include vector fields and maps, conjugacies, structural stability and Peixoto's theorem, dynamical systems on two-manifolds; center manifold theory and normal forms for vector fields and maps; local bifurcations of vector fields and maps, co-dimension 1 and 2 bifurcations; global bifurcations, the Smale horseshoe map and invariant Cantor sets, the shift map and symbolic dynamics, chaos in the horseshoe, Conley – Moser conditions for chaos, hyperbolic invariant sets, Moser's theorem and Smale-Birkhoff homoclinic theorem, homoclinic bifurcations and Newhouse sinks; homoclinic and subharmonic Melnikov theories, conditions for homoclinic chaos, chaos in perturbed Hamiltonian systems; applications to mechanics. This course will demonstrate how these advanced concepts can be applied to the study of response, stability and bifurcation behavior of engineering systems. Same as TAM 516. 4 graduate hours. No professional credit. Prerequisite: TAM 416 and either ME 340, TAM 412 or AE 352.

AE 555 Multivariable Control Design credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/555/**)**
Frequency-response design specifications; algebraic and analytic constraints in scalar systems; uncertainty representation; Nyquist stability theory, small gain condition, and multi-input multi-output systems; singular value decomposition; robustness and u-function; linear quadratic regulator based design; recovery of LQ Design properties; Kalman filter; Riccati equations; H-infinity based design; reduction; balanced truncation; Hankel singular values; coprime factor reduction; loop shaping. Same as SE 521. 4 graduate hours. No professional credit. Prerequisite: ECE 515.

AE 556 Robust Control credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/556/**)**
Signal and system spaces; stability, robustness, and the small gain theorem; factorization and parameterization of all stabilizing controllers; performance and achievable closed loop maps; model matching; design of optimal single-input single-output systems in H-infinity, H2, L1 senses; extensions to multi-output systems; structured and unstructured uncertainty; robust performance analysis and synthesis; multi-objective control. Prerequisite: ECE 515 and MATH 446.

AE 560 Fracture Mechanics Laboratory credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/560/**)**
Experimental and physical aspects of fracture mechanics including elastic crack tip stress field, thermoelasticity, thermoplasticity, optical techniques, J-integral, toughening mechanisms, dynamic fracture, and fatigue. Laboratory experiments illustrate concepts. Prerequisite: TAM 451 or TAM 551.

AE 564 Advanced Aero Propulsion Lab credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/564/**)**
Theory and application of advanced diagnostic techniques used in aerodynamics and propulsion research with an emphasis placed on wind tunnel testing and advanced optical and laser-based techniques. Experience with aircraft performance measurement, wind tunnel testing, schlieren/shadowgraph photography, interferometry, spectroscopy, laser Doppler velocimetry, particle and molecular-based scattering, particle image velocimetry, pressure/temperature/shear sensitive paint, and other recently developed techniques provided through lectures and laboratory exercises.Prerequisites: AE 311, AE 312, AE 433, AE 460.

AE 583 Advanced Robotic Planning credit: 4 Hours. **(**https://courses.illinois.edu/schedule/terms/AE/583/**)**
Same as ECE 550. See ECE 550.

AE 590 Seminar credit: 0 Hours. (https://courses.illinois.edu/schedule/terms/AE/590/)
Presentation by graduate students, staff, and guest lecturers of current topics in aerospace engineering. Approved for S/U grading only.

AE 597 Independent Study credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/597/)
Independent theoretical and experimental projects in aerospace engineering. May be repeated. Prerequisite: Consent of instructor.

AE 598 Special Topics credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/AE/598/)
Subject offerings of new and developing areas of knowledge in aerospace engineering intended to augment existing formal courses. Topics and prerequisites vary for each section. See Class Schedule or departmental course information for both. May be repeated in the same or separate terms if topics vary to a maximum of 12 hours.

AE 599 Thesis Research credit: 0 to 16 Hours. (https://courses.illinois.edu/schedule/terms/AE/599/)
Research in the various areas of aerospace engineering. Approved for S/U grading only. May be repeated.