ASE - Aerospace Engineering

Aerospace Engineering: ASE

Lower-Division Courses

ASE 102. Introduction to Aerospace Engineering.

Restricted to first year students. Introduction to aerospace engineering, including problem solving and study skills. Examines opportunities and responsibilities of careers in aerospace engineering. One lecture hour a week for one semester. May not be counted toward any engineering degree. Offered on the pass/fail basis only.

ASE 118. Student Leadership Seminar.

Principles of human development, strategic learning, and teaching. Small-group seminar involving reading, discussion, and written reports. One lecture hour a week for one semester. Offered on the pass/fail basis only. Prerequisite: Consent of the engineering undergraduate adviser.

ASE 119K. Low-Speed Aerodynamics Laboratory.

Restricted to students in the aerospace engineering major sequence. Wind tunnel and water channel experiments at subsonic speeds; use of instrumentation and written reports. One lecture hour and three laboratory hours a week for one semester. Aerospace Engineering 119K and 120K may not both be counted.

ASE 119L. High-Speed Aerodynamics Laboratory.

Restricted to students in the aerospace engineering major sequence. Experiments using a variable-Mach number supersonic wind tunnel and ballistics range, and an investigation of aerodynamics of blunt bodies and simple airfoils in supersonic flow. One lecture hour and three laboratory hours a week for one semester. Aerospace Engineering 119L and 162M may not both be counted.

ASE 119M. Spacecraft Systems Laboratory.

Restricted to students in the aerospace engineering major sequence. Overview of spacecraft subsystems, mission design tools, numerical techniques, mission planning references, mission constraints, and mission design projects. Includes written reports. One lecture hour and one and one-half laboratory hours a week for one semester. Aerospace Engineering 119M and 166M may not both be counted.

ASE 119N. Flight Dynamics Laboratory.

Restricted to students in the aerospace engineering major sequence Introduction to flight testing; instrumentation and methodology; performance testing. Computer modeling and dynamic simulation of aircraft motion; aircraft sizing. Written reports. One lecture hour and three laboratory hours a week for one semester.

ASE 119S, 219S, 319S, 419S, 519S, 619S, 719S, 819S, 919S. Topics in Aerospace Engineering.

Used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office or the school's International Engineering Education Programs. Credit is recorded as assigned by the study abroad adviser in the Department of Aerospace Engineering and Engineering Mechanics. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. May be repeated for credit when the topics vary. Offered on the letter-grade basis only.

Upper-Division Courses

ASE 320. Low-Speed Aerodynamics.

Fundamental concepts, fluid statics; integral and differential analysis; detailed analysis of inviscid, incompressible flows; aerodynamics of airfoils and wings. Three lecture hours a week for one semester. Prerequisite: Mathematics 427L, and Mechanical Engineering 310T or 320, with a grade of at least C- in each.

ASE 120K. Low-Speed Aerodynamics Laboratory.

Wind tunnel and water channel experiments at subsonic speeds; use of instrumentation and written reports. One lecture hour and three laboratory hours a week for one semester. Prerequisite: Credit with a grade of at least C- or registration for Aerospace Engineering 320; Credit with a grade of at least C- or registration for one of the following: Aerospace Engineering 333T, Biomedical Engineering 333T, Chemical Engineering 333T, Civil Engineering 333T, Electrical Engineering 333T, Engineering Science 333T, Mechanical Engineering 333T, or Petroleum and Geosystems Engineering 333T; and Mathematics 427L with a grade of at least C-.

ASE 321K. Computational Methods for Structural Analysis.

Same as Computational Engineering 321K. Matrix structural analysis of systems that can be idealized as being comprised of axial bar elements, beam elements, and frame elements. Notion of element-by-element assembly of the governing system of algebraic equations. A systematic introduction to (and use of) the fundamental idea of a weak statement of a boundary value problem, particularly as concerns the numerical treatment/approximation of such problems. Interpretation of the weak-statement in terms of the principle of virtual work. Galerkin's method as applied to structural analysis. An introduction to the classical Galerkin finite element method with application to structures and plane elasticity. Energy principles and their utility in solving problems in solid mechanics, as well as their connection to the finite element method. Three lecture hours a week for one semester, with discussion hours to be arranged. Aerospace Engineering 321K and Computational Engineering 321K may not both be counted. Prerequisite: Computational Engineering 311K (or Aerospace Engineering 211K or Computational Engineering 211K); and Engineering Mechanics 319 with a grade of at least C- in each.

ASE 324L. Aerospace Materials Laboratory.

Study of the deformation and fracture behavior of materials used in aerospace vehicles. Structure-property relations, methods of characterizing material behavior, use of properties in the design process. Case histories. Written reports. Two lecture hours and three laboratory hours a week for one semester. Prerequisite: Engineering Mechanics 319 with a grade of at least C-.

ASE 128. Aerospace Engineering Projects Laboratory.

Directed work on an organized student project in aerospace engineering or engineering mechanics. The equivalent of one lecture hour a week for one semester. May be repeated for credit. Offered on the pass/fail basis only. Prerequisite: At least fifteen semester hours of coursework, a University grade point average of at least 2.50, preparation of a laboratory participation log and written report, and approval by both the faculty member directing the student project and the undergraduate adviser.

ASE 330M. Linear System Analysis.

Explore the fundamentals of signals and systems; mathematical modeling of mechanical systems; transfer function; impulse response; Laplace transforms; response of linear, time-invariant systems; frequency response methods; time-domain analysis; introductory concepts for feedback control systems; multivariate linear dynamical systems; eigenvalues and eigenvectors; matrix exponentials. An introduction to fundamental elements of the theory of systems and signals and exposure to necessary concepts and tools required to perform modeling and analysis of linear dynamical systems. Demonstrate the theory through several simulation examples using MATLAB and Simulink relevant to applications of modern aerospace engineering systems. Three lecture hours a week for one semester. Prerequisite: Engineering Mechanics 311M, and Mathematics 427J or 427K with a grade of at least C- in each; and credit with a grade of at least C- or registration for Computational Engineering 311K (or Aerospace Engineering 211K or Computational Engineering 211K).

ASE 333T. Engineering Communication.

Restricted to aerospace engineering and computational engineering majors. Technical communication skills for engineers: written and oral reports; individual and collaborative composition; online and traditional research; editing techniques; document design for electronic and hard copy. Three lecture hours a week for one semester. Only one of the following may be counted: Aerospace Engineering 333T, Biomedical Engineering 333T, Communication 333T, Civil Engineering 333T, Chemical Engineering 333T, Electrical and Computer Engineering 333T, Electrical Engineering 333T, Engineering Studies 333T, Mechanical Engineering 333T, Petroleum and Geosystems Engineering 333T. Prerequisite: English 303C (or 603A) or Rhetoric and Writing 306 with a grade of at least C-.

ASE 339. Advanced Strength of Materials.

Same as Engineering Mechanics 339. Curved beams, shear deformation, beam columns, beams on elastic foundations; inelastic behavior of members; elementary plate bending. Three lecture hours a week for one semester. Prerequisite: Engineering Mechanics 319 with a grade of at least C-.

ASE 346. Viscous Fluid Flow.

Navier-Stokes equations, laminar and turbulent boundary layers, transition, effects of pressure gradients, heat transfer, and compressibility. Three lecture hours a week for one semester. Prerequisite: Aerospace Engineering 320 with a grade of at least C-.

ASE 355. Aeroelasticity.

Static aeroelastic phenomena; wing torsional divergence, control reversal, effect of wing sweep, flexibility effects on aircraft stability and control, and design implications; dynamic aeroelasticity; and galloping of transmission lines, flutter, and unsteady aerodynamics. Includes an introduction to experimental aeroelasticity. Three lecture hours a week for one semester. Prerequisite: Aerospace Engineering 320 and 365 with a grade of at least C- in each.

ASE 357. Mechanics of Composite Materials.

Anisotropic constitutive relationships, lamination theory, failure theories, micromechanical behavior of laminates; laminated composite plates--bending, vibration, and buckling; composite fabrication, sandwich and other composite lightweight structures. Three lecture hours a week for one semester. Prerequisite: Engineering Mechanics 319 with a grade of at least C-.

ASE 361K. Aircraft Design I.

Systems engineering based approach to conceptual design and analysis of an aircraft system to meet top-level mission requirements. Selected hands-on lab projects included. Three lecture hours and four laboratory hours a week for one semester. Prerequisite: Aerospace Engineering 320 with a grade of at least C-, and credit with a grade of at least C- or registration for Aerospace Engineering 367K.

ASE 361L. Aircraft Design II.

Systems Engineering based aircraft preliminary and detail design, build, flight test, and demonstration. The overall approach is applicable to all aircraft but the specific project is a small unmanned air system designed to meet defined mission requirements. Three lecture hours and four laboratory hours a week for one semester. Prerequisite: Aerospace Engineering 119K or 120K, and 361K with a grade of at least C- in each.

ASE 362K. Compressible Flow.

Shock and expansion waves, quasi-one-dimensional flow, converging-diverging nozzles, diffusers, linearized flow, and compressibility effects on aerodynamics of airfoils and bodies. Three lecture hours a week for one semester. Prerequisite: Aerospace Engineering 320 with a grade of at least C-.

ASE 162M. High-Speed Aerodynamics Laboratory.

Experiments using a variable-Mach number supersonic wind tunnel and shock tube. Aerodynamics of wedges, cones, spheres and diamond-shaped airfoils in supersonic flow. One-dimensional unsteady shock motion. High-speed flow measurement techniques. One lecture hour and three laboratory hours a week for one semester. Prerequisite: Aerospace Engineering 362K with a grade of at least C-.

ASE 363L. History of Space Flight.

History and principles of space flight from early Chinese rocket experiments to Apollo 17 and the Space Shuttle; technological benefits from the space program and future space projects, including commercial space activities and those related to national security. Three lecture hours a week for one semester. May not be counted as an aerospace engineering course for the Bachelor of Science in Aerospace Engineering; may not be counted as a technical elective, a technical area course, or an engineering elective for any engineering degree. Prerequisite: Upper-division standing or consent of instructor.

ASE 364. Applied Aerodynamics.

Detailed analysis of aerodynamics of compressible and incompressible flows about wings and airfoils; wing and airfoil parameters and force and moment coefficients; and thin-airfoil theory, lifting-line theory, panel methods, high-lift devices, delta wings, transonic flows, and supersonic flows over wings. Three lecture hours a week for one semester. Aerospace Engineering 364 and 379L (Topic: Airfoil and Wing Design Theory) may not both be counted. Prerequisite: Aerospace Engineering 362K with a grade of at least C-.

ASE 365. Structural Dynamics.

Analysis of discrete and continuous vibrating systems; deriving equations of motion; determining response; and natural frequencies and modes of vibration. Three lecture hours a week for one semester. Prerequisite: Engineering Mechanics 319 with a grade of at least C-.

ASE 366K. Spacecraft Dynamics.

Examine Newton's gravity law, Kepler's laws, basic orbit propagation, orbit properties, orbital elements, coordinate systems and transformations, radar observations, ground tracks, orbit maneuvers, and trajectory design principles. Three lecture hours a week for one semester. Prerequisite: Computational Engineering 311K (or Aerospace Engineering 211K or Computational Engineering 211K), Engineering Mechanics 311M, and Mathematics 427J or 427K with a grade of at least C- in each.

ASE 366L. Applied Orbital Mechanics.

Selected subjects in satellite motion and satellite applications, including communication and navigation satellites, orbit selection/design for satellite applications, orbital coordinate systems, time, major perturbing forces, rendezvous and intercept, and interplanetary trajectories. Three lecture hours a week for one semester. Prerequisite: Aerospace Engineering 366K with a grade of at least C-.

ASE 166M. Spacecraft Systems Laboratory.

Overview of spacecraft subsystems, mission design program library, numerical techniques, mission planning references, mission constraints, and mission design projects. Includes written reports. One and one-half lecture hours and one and one-half laboratory hours a week for one semester. Prerequisite: Aerospace Engineering 366K with a grade of at least C-, and credit with a grade of at least C- or registration for Aerospace Engineering 374K.

ASE 367K. Flight Dynamics.

Equations of motion for rigid aircraft; aircraft performance, weight and balance, static stability and control, and dynamic stability; design implications. Three lecture hours a week for one semester. Prerequisite: Aerospace Engineering 320 with a grade of at least C-.

ASE 370C. Feedback Control Systems.

Fundamentals of linear control analysis and design for single-input, single-output systems; stability and performance measures; Routh Hurwitz analysis; root locus methods; frequency response (Bode and Nyquist); introduction to full-state feedback. Three lecture hours a week for one semester. Aerospace Engineering 370C and 370L may not both be counted. Prerequisite: Aerospace Engineering 330M with a grade of at least C-.

ASE 170P. Controls Laboratory.

Three laboratory hours a week for one semester. Prerequisite: Aerospace Engineering 370L with a grade of at least C-.

ASE 372K. Attitude Dynamics.

Examine attitude representations, rotational kinematics, rigid-body dynamics, and torque-free motion. Explore satellite's sensors and actuators, attitude determination algorithms, and passive and active attitude control systems. Three lecture hours a week for one semester. Prerequisite: Aerospace Engineering 330M and 366K with a grade of at least C- in each.

ASE 372L. Satellite Applications.

Classical and modern orbit determination, remote sensors and their outputs, pattern recognition, image enhancement, satellite data analysis projects. Three lecture hours a week for one semester. Prerequisite: Aerospace Engineering 366K with a grade of at least C-.

ASE 372N. Satellite-Based Navigation.

Satellite-based navigation systems, with focus on the Global Positioning System (GPS), ground and space segments, receiver location estimation, astrodynamics, satellite signal coordinate/time systems, differential techniques, GPS data analysis. Three lecture hours a week for one semester. Prerequisite: Aerospace Engineering 366K with a grade of at least C-.

ASE 374K. Space Systems Engineering Design.

Introduction to systems engineering: the systems engineering process, requirements, design fundamentals, trade studies, cost and risk analyses, integration, technical reviews, case studies, and ethics. Includes written reports. Three lecture hours and four laboratory hours a week for one semester. Aerospace Engineering 374K and Computational Engineering 373 may not both be counted. Prerequisite: Aerospace Engineering 366K with a grade of at least C-.

ASE 374L. Spacecraft/Mission Design.

Spacecraft systems characteristics, mission requirements, sensors, and consumables analyses; and mission phases, request for proposal, problem definition, ideation, proposal preparation, conceptual design review, preliminary design development and review, and design report preparation. Includes written reports. Three lecture hours and four laboratory hours a week for one semester. Prerequisite: Aerospace Engineering 166M and 374K with a grade of at least C- in each.

ASE 375. Electromechanical Systems.

Restricted to aerospace engineering and computational engineering majors. Subjects include basic electronic circuits, operational amplifiers, concepts of impedance and feedback, sensors to measure temperature, displacement, strain, force and acceleration, impulse testing, shake testing, and triggered data acquisition. These concepts will be implemented via experiments that illustrate interesting phenomena in solids and structures. Two lecture hours and three laboratory hours a week for one semester. Aerospace Engineering 375 and Mechanical Engineering 340 may not both be counted. Prerequisite: Engineering Mechanics 319 and Physics 303L with a grade of at least C- in each.

ASE 376C. Rocket Engineering Practicum I.

An introduction to rocket engineering. Explore a high-level overview of the principles, systems, and design methodologies required to design a vehicle capable of going to space. Participate in project-based work embedded within actual systems of the Texas Rocket Engineering Laboratory. Three lecture hours a week for one semester. Aerospace 376C and 379L (Topic: Rocket Engineering Practicum) may not both be counted.

ASE 376D. Rocket Engineering Practicum II.

Explore the industry-relevant design and production environment encountered when working on a rocket subsystem in depth. Participate in project work embedded within systems of the Texas Rocket Engineering Laboratory. Three lecture hours a week for one semester. Aerospace Engineering 376D and 379L (Topic: Rocket Engr Practicum II) may not both be counted. Prerequisite: Aerospace Engineering 376C with a grade of at least C-.

ASE 376K. Propulsion.

Review of control volume analysis and quasi-one-dimensional compressible flow. Simple propeller theory. Analysis and design of rocket nozzles and air-breathing engines, including performance and cycle analysis; flow in nozzles, diffusers, compressor, and turbine stages; combustion chamber processes and propellants. Includes an introduction to chemical rocket propulsion. Three lecture hours a week for one semester. Prerequisite: Aerospace Engineering 362K with a grade of at least C-.

ASE 679H. Undergraduate Honors Thesis.

Research performed during two consecutive semesters under the supervision of an engineering faculty member; topics are selected jointly by the student and the faculty member with approval by the director of the Engineering Honors Program. The student makes an oral presentation and writes a thesis. Individual instruction for two semesters. Students pursuing both the Bachelor of Arts, Plan II, and a Bachelor of Science in Engineering may use this course to fulfill the thesis requirement for the Bachelor of Arts, Plan II. Prerequisite: For 679HA, enrollment in the Engineering Honors Program; for 679HB, Aerospace Engineering 679HA and enrollment in the Engineering Honors Program.

ASE 179K, 279K, 379K. Research in Aerospace Engineering.

Restricted to aerospace engineering majors. Directed study or research in a selected area of aerospace engineering. One, two, or three lecture hours a week for one semester. May be repeated for credit. Prerequisite: Upper-division standing, a University grade point average of at least 3.00, selection of project, and consent of the faculty member directing project and the undergraduate adviser.

ASE 379L. Studies in Aerospace Engineering.

Current topics in aerospace engineering. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Varies with the topic.

Topic 1: Selected Topics in Fluid Mechanics.
Topic 2: Selected Topics in Structural Mechanics.
Topic 3: Selected Topics in Flight Mechanics.
Topic 4: Selected Topics in Orbital Mechanics.
Topic 9: Selected Topics in Controls.

ASE 179R. Research Seminar.

Designed for students who plan to pursue a substantial research project or undergraduate honors thesis in aerospace engineering. Department faculty present information and lead discussions about their current research projects so that students can learn about available research opportunities. One lecture hour a week for one semester. May not be repeated for credit. Offered on the pass/fail basis only. Prerequisite: Completion of at least twenty-four semester hours of coursework and a University grade point average of at least 3.50.

ASE 179S, 279S, 379S, 479S, 579S, 679S, 779S, 879S, 979S. Topics in Aerospace Engineering.

Used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office or the school's International Engineering Education Programs. Credit is recorded as assigned by the study abroad adviser in the Department of Aerospace Engineering and Engineering Mechanics. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. May be repeated for credit when the topics vary. Offered on the letter-grade basis only.

ASE 479W. Aerial Robotics.

Comprehensive introduction to robotic aircraft. Examine rotorcraft dynamics modeling, feedback control, sensing, state estimation, path planning, machine vision, and decision-making under uncertainty. Design an automation protocol, written in C++, that commands a squad of quadcopters competing in a game. Three lecture hours and three laboratory hours a week for one semester. Aerospace Engineering 379L (Topic: Aerial Robotics) and 479W may not both be counted. Prerequisite: Aerospace Engineering 330M with a grade of at least C-.

Graduate Courses

ASE 380P. Mathematical Analysis for Aerospace Engineers.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Analytical Methods I. Introduction to modern mathematics, real analysis of functions of one variable, linear algebra, elements of real analysis of functions of many variables, calculus of variations. Aerospace Engineering 380P (Topic 1) and Engineering Mechanics 386K may not both be counted.
Topic 2: Analytical Methods II. Elements of complex analysis, Fourier and Laplace transforms, ordinary and partial differential equations, perturbation methods. Only one of the following may be counted: Aerospace Engineering 380P (Topic 2), Computational Science, Engineering, and Mathematics 386L, Engineering Mechanics 386L.

ASE 381P. System Theory.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Linear Systems Analysis. Linear dynamical systems; controllability and observability; stability; realization theory; state-feedback and observers.
Topic 2: Multivariable Control Systems. Multivariable feedback systems; factorizations and controller parameterization; limitations and trade-offs of feedback; robust stability and performance; robust H2 and H-infinity control methods. Additional prerequisite: Aerospace Engineering 381P (Topic 1) or the equivalent.
Topic 3: Optimal Control Theory. Unconstrained and constrained finite-dimensional optimization, introduction to calculus of variations and optimal control, necessary and sufficient conditions for optimality, Pontryagin's Maximum Principle, minimum-time control, linear quadratic optimal control theory, introduction to dynamic programming, Hamilton-Jacobi-Bellman equation.
Topic 4: Numerical Methods in Optimization. Numerical methods for solving parameter optimization, suboptimal control, and optimal control problems.
Topic 6: Statistical Estimation Theory. Modeling static and dynamic systems, linear and nonlinear estimation, Bayesian estimation, batch least squares, Kalman filtering, square-root and information filtering, introduction to advanced estimation methods.
Topic 7: Advanced Topics in Estimation Theory. Estimation in the presence of unmodeled accelerations; nonlinear estimators; continuous estimation methods. Additional prerequisite: Aerospace Engineering 381P (Topic 6).
Topic 9: Human Centered Robotics. Aerospace Engineering 381P (Topic 9) and 381P (Topic 13) may not both be counted.
Topic 10: Learning for Dynamics and Controls. Aerospace Engineering 389 (Topic: Learning for Dynamics/Controls) and Aerospace Engineering 381P (Topic 10) may not both be counted.
Topic 11: Nonlinear Dynamics and Control. Analysis and synthesis of nonlinear control systems. Stability theory, Center manifold analysis, feedback linearization, backstepping, time-scale separations, nonlinear observers, Aeromechanical system applications. Aerospace Engineering 381P (Topic 11) and 396 (Topic: Nonlinear Dynamics and Control) may not both be counted. Additional prerequisite: Aerospace Engineering 381P (Topic 1) or the equivalent, and consent of instructor.
Topic 14: System ID and Adaptive Control. System identification, persistence of excitation, model reference adaptive control, projection operators, immersion and invariance techniques, applications to aeromechanical systems. Aerospace Engineering 381P (Topic 14) and 396 (Topic: System ID and Adaptive Control) may not both be counted. Additional prerequisite: Aerospace Engineering 381P (Topic 1) or the equivalent.
Topic 15: Formal Methods for Robotics. Aerospace Engineering 381P (Topic 15) and 389 (Topic: Ver/Synth Cybrphysicl Systm) may not both be counted.

ASE 382Q. Fluid Mechanics.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Foundations of Fluid Mechanics. Fundamental equations; constitutive equations for Newtonian fluids; inviscid, incompressible potential flow; viscous flow including exact solutions and boundary layer theory; compressible flow.
Topic 7: Advanced Problems in Compressible Flow. Physics and modeling of compressible fluids; types and structure of shock waves; heat conduction and secondary viscosity effects; exact nonlinear flow models.
Topic 8: Lagrangian Methods in Computational Fluid Dynamics. Particle-based methods of computational fluid dynamics: molecular

dynamics, direct simulation Monte Carlo, cellular automata, lattice Boltzmann, particle in cell, point vortex, immersed boundary.

Topic 9: Turbulent Mixing. Fundamentals of turbulent scalar mixing relevant to turbulent combustion. Includes governing equations, mass diffusion, scalar transport, kinematics, chaotic advection, vortex dynamics, small-scale structure of vorticity and dissipative fields, scalar dissipation rate, scaling laws for canonical flows, heat release effects, and turbulent jet flame structure.

Topic 10: Plasmas and Reactive Flows. Fundamental description of plasmas and reactive flows. Includes derivation of common governing transport equations for a broad class of electrically conducting and nonconducting reactive gases, and electromagnetic field interactions with gases, gas-phase and surface kinetics, transport properties, and applications.

Topic 11: Foundations of Computational Fluid Dynamics. Higher-order numerical methods for solving partial differential equations and ordinary differential equations. Focus on the numerical computation of fluid flows, with a variety of scientific applications. Aerospace Engineering 382Q (Topic 11) and Aerospace Engineering 396 (Topic: Foundations of Computational Fluid Dynamics) may not both be counted.

ASE 382R. Aerodynamics.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 3: Hypersonic Aerodynamics. Characteristics and assumptions of hypersonic flow; hypersonic similitude; Newtonian theory; constant density solutions.

Topic 5: Advanced Computational Methods. Development and implementation of numerical methods for solution of transport equations; computational grid generation; applications to fluid flows, including shock waves.

Topic 6: Molecular Gas Dynamics. Same as Mechanical Engineering 381Q (Topic 4). Kinetic theory, chemical thermodynamics, statistical mechanics. Applications: equilibrium gas properties, chemical kinetics, interaction of matter with radiation, rarefied gas dynamics. Additional prerequisite: Consent of instructor

Topic 7: Optical Diagnostics for Gas Flows. Fundamentals of nonintrusive flowfield diagnostics for aerodynamics and combustion. Basics of lasers and optical detectors; interferometric methods; Rayleigh, Raman, and Mie scattering; absorption spectroscopy; laser-induced fluorescence.

ASE 384P. Structural and Solid Mechanics.

Three lecture hours or two lecture hours and three laboratory hours a week for one semester, depending on the topic. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Solid Mechanics I. Same as Engineering Mechanics 388. Mathematical description of stress, deformation, and constitutive equations of solid mechanics; boundary value problems of elasticity. Three lecture hours a week for one semester.

Topic 2: Solid Mechanics II. Same as Engineering Mechanics 388L. Continuation of Engineering Mechanics 388. Additional topics in elasticity, plasticity, viscoelasticity, variational methods, and other areas of solid mechanics. Three lecture hours a week for one semester. Prerequisite: Graduate standing, Engineering Mechanics 388 or Aerospace Engineering 384P (Topic 1), and consent of instructor.

Topic 3: Structural Dynamics. Same as Engineering Mechanics 384L. Free and forced vibration of single-degree-of-freedom, multiple-degree-of-freedom, and continuous systems. Lagrange's equations and Hamilton's principle; discretization of continuous systems; numerical methods for response and algebraic eigenvalue problems. Three lecture hours a week for one semester.

Topic 4: Finite Element Methods. Same as Computational Science, Engineering, and Mathematics 393F and Engineering Mechanics 394F. Derivation and implementation of the finite element method; basic coding techniques; application to problems of stress and diffusion. Three lecture hours a week for one semester. Only one of the following may be counted: Aerospace Engineering 384P (Topic 4), Computational Science, Engineering, and Mathematics 393F, Engineering Mechanics 394F. Additional prerequisite: Graduate standing and consent of instructor.

Topic 6: Advanced Structural Dynamics. Analysis of complex flexible systems; discretization of complex structures by the finite element method; advanced computational methods for large finite element models. Three lecture hours a week for one semester. Additional prerequisite: Aerospace Engineering 384P (Topic 3) or Engineering Mechanics 384L or the equivalent.

Topic 8: Selected Topics in Aeroelasticity. Classical and contemporary topics in aeroelasticity; general introduction to aeroelastic phenomena, including flutter, divergence, control reversal, and flexibility effects on stability and control; aeroelastic tailoring; active control concepts; unsteady aerodynamic theories for lifting surfaces and bodies; aeroelastic system identification, including nonlinear systems (theory and laboratory applications). Three lecture hours a week for one semester.

Topic 11: Mechanics of Composite Materials. Constitutive equations; micromechanical and macromechanical behavior of lamina; strength and stiffness in tension and compression, theory of laminated plates; strength of laminates; delamination. Three lecture hours a week for one semester.

ASE 387P. Flight Mechanics, Guidance, Navigation, and Control.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 2: Mission Analysis and Design. Mission design and mission constraints, launch windows; rendezvous analysis; orbital design interactions with thermal and structural analysis; design of a typical mission.

Topic 6: Optimal Spacecraft Trajectories. Optimal control of spacecraft; primer vector theory; impulsive maneuvers; finite burn high/low thrust maneuvers; solar sails; numerical methods; applications to contemporary trajectory problems using single or multiple spacecraft.

Topic 7: Sensors and Actuators. Students use LabVIEW to study aerospace devices such as inertial navigation systems, control-moment gyroscopes, optical navigation systems, torque coils and magnetometers, robots, and integrated satellites.

ASE 388P. Celestial Mechanics.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 2: Celestial Mechanics I. N-body problem; three-body problem; restricted three-body problem; Jacobian integral; zero-velocity curves; equilibrium points; stability; linearized solutions; variational equations; periodic orbits; the two-body problem; variation of parameters; Lagrange's planetary equations; applications to near-earth and deep-space trajectories; numerical methods.

Topic 3: Celestial Mechanics II. Hamiltonian mechanics; dynamical systems; canonical transformations; invariant manifolds; Poincare surfaces of section; applications to restricted n-body problems; applications to sun-earth-moon or sun-planet-moon particle trajectory problems. Additional prerequisite: Aerospace Engineering 388P (Topic 2).

ASE 189, 289, 389, 489, 589, 689. Topics in Aerospace Engineering.

For each semester hour of credit earned, one lecture hour a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

ASE 389P. Satellite Applications.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Determination of Time. Concepts of time; fundamental reference system; polar motion; practical methods in time determination and dissemination; historical and present-day time scales; atomic clocks; time transfer via satellite.
Topic 2: Satellite Geodesy. Explore theory of the gravitational potential, including its time-variations; spherical harmonics and other representations; space-based remote sensing of the geopotential and its gradients; mass flux variability and its applications.
Topic 4: Methods in Orbit Determination. Variational methods of the orbit determination, Orbit parameter estimation, satellite tracking techniques and observables, modern precision orbit determination. Three lecture hours a week for one semester. Aerospace engineering 389P (Topic 4) and 396 (Topic: Orbit Determination) may not both be counted. Additional prerequisite: Aerospace Engineering 381P (Topic 6) or equivalent.
Topic 7: Global Navigation Satellite System Signal Processing. Comprehensive review of the theory and applications of the Global Positioning System (GPS), including the space segment, the control segment, the user segment, dilution of precision, GPS time, antispoofing, selected availability, differential/kinematic/dynamic techniques, field procedures, and GPS data collection and analysis. Applications of ground-based, aircraft-based, and satellite-based GPS receivers.
Topic 8: Satellite Control Systems. Spacecraft equations of motion; linearization and stability, classical control methods; digital and sampled data systems; multivariable control; attitude determination and control; momentum management; coupled modes; and case studies in satellite control.
Topic 9: Synthetic Aperture Radar: Principles and Applications. Synthetic Aperture Radar (SAR) imaging for Earth remote sensing, including image formation concepts and interpretation, radar interferometry processing and strategies, surface deformation, topographic mapping, and polarimetric applications.
Topic 10: Fundamentals and Geophysical Application of Imaging Radar Systems. Exploration of how radar images are formed and manipulated, as well as applications of the systems to problems such as measurement of the Earth crustal deformation. Focus on radar as a signal processing problem, radar image formation, polarimetric radars, and radar interferometry. Subjects include system design, scattering from natural surfaces, range and azimuth processing algorithms, and processor design. Additional prerequisite: Knowledge of Fourier Transform and at least one programming language (MATLAB, C or Fortran).
Topic 11: Advanced Satellite Geodesy. Examine kinematics and dynamics of displacement and Earth orientation. Investigate the determination of time and reference frames. Explore deformations of the Earth due to tides and mass loading. Study modern space geodetic applications. Additional prerequisite: Aerospace Engineering 389P (Topic 2).

ASE 397. Graduate Seminar.

Student, faculty, and visitor presentations of current research topics. Three lecture hours a week for one semester. May be repeated for credit. Offered on the credit/no credit basis only. Prerequisite: Graduate standing.

ASE 197R, 297R, 397R, 497R, 597R, 697R, 797R, 897R, 997R. Research in Aerospace Engineering.

For each semester hour of credit earned, the equivalent of one lecture hour a week for one semester. May be repeated for credit. Offered on the credit/no credit basis only. Prerequisite: Graduate standing and consent of instructor.

ASE 698. Thesis.

The equivalent of three lecture hours a week for two semesters. Offered on the credit/no credit basis only. Prerequisite: For 698A, graduate standing in aerospace engineering and consent of the graduate adviser; for 698B, Aerospace Engineering 698A.

ASE 398R. Master's Report.

Preparation of a report to fulfill the requirement for the master's degree under the report option. The equivalent of three lecture hours a week for one semester. Offered on the credit/no credit basis only. Prerequisite: Graduate standing in aerospace engineering and consent of the graduate adviser.

ASE 398T. Supervised Teaching in Aerospace Engineering.

Teaching methods and objectives, criteria for evaluating teaching effectiveness, procedural rules and regulations, laboratory teaching. Three lecture hours a week for one semester. Offered on the credit/no credit basis only. Prerequisite: Graduate standing and appointment as a teaching assistant.

ASE 399W, 699W, 999W. Dissertation.

May be repeated for credit. Offered on the credit/no credit basis only. Prerequisite: Admission to candidacy for the doctoral degree.

Professional Courses