AE - Aerospace Engineering

Courses numbered 100 to 299 = *lower-division*; 300 to 499 = *upper-division;* 500 to 799 = *undergraduate/graduate*.

AE 223. Statics (3).
Studies the condition of equilibrium of rigid bodies under the action of forces. Rigid bodies include beams, trusses, frames and machines. Considers both two- and three-dimensional bodies. Also studies centroids, centers of gravity and moments of inertia. Prerequisite: PHYS 313. Pre- or corequisite: MATH 243.

AE 227. Engineering Digital Computation (3).
2 Classroom hours; 2 Lab hours. MATLAB and Visual-Basic programming; introduces linear algebra and matrix methods for engineers, selected numerical methods for approximating functions, solution of systems of equations, numerical integration, and numerical determination of the roots of polynomials. Pre- or corequisite: MATH 243. Corequisite: AE 227L.

AE 281I. Noncredit Internship (0).
Complements and enhances the student's academic program by providing an opportunity to apply and acquire knowledge in a workplace environment as an intern. Prerequisite: departmental consent.

AE 324. Fundamentals of Atmospheric Flight (3).
Studies the atmosphere, aircraft and aerodynamic nomenclature. Introduces aerodynamic theory, airfoils, wings, aircraft performance, stability and control, and propulsion. Prerequisite: AE 223 (no grade lower than one that generates 2.000 or more credit points per credit hour will be accepted for this course). Pre- or corequisite: AE 227.

AE 333. Mechanics of Materials (3).
Studies the mechanical properties of materials, transformation of stresses and strains, stresses and deformations in structural elements of various shapes and loading, statically indeterminate structures, and buckling. Prerequisite: AE 223 (no grade lower than one that generates 2.000 or more credit points per credit hour will be accepted for this course). Pre- or corequisite: MATH 344 or MATH 555.

AE 373. Dynamics (3).
Studies the kinematics and kinetics of particles and rigid bodies. Includes force-mass-acceleration, work-energy and impulse-momentum methods. Prerequisites: AE 223 (no grade lower than one that generates 2.000 or more credit points per credit hour will be accepted for this course), and MATH 344.

AE 415. Introduction to Space Dynamics (3).
Fundamentals of orbital mechanics and rigid body dynamics, two-body problems, orbital maneuvers and orbital determination, rigid body kinematics, and kinetics. Prerequisites: AE 227 and AE 373 (no grade lower than one that generates 2.000 or more credit points per credit hour will be accepted for AE 373). Pre- or corequisite: MATH 555.

AE 424. Aerodynamics I (3).
Studies the dynamics of incompressible potential flow, governing equations of motion in control volume form and differential form, rotation and vorticity, stream function and velocity potential, singularities and superposition, introduction to panel methods, various two-dimensional airfoil theories, finite wing theory, flow over axisymmetric bodies, application tools for aerodynamic design and analysis. Prerequisites: MATH 555, AE 324 (no grade lower than one that generates 2.000 or more credit points per credit hour will be accepted for these courses), and AE 373.

AE 460. Selected Topics (1-3).
New or special topics presented on sufficient demand. Repeatable for credit when subject material warrants. Prerequisite: instructor's consent.

AE 460A. Aerospace Colloquium (0).
Zero credit hour course specifically for freshmen aerospace engineering students. Includes faculty and industry engineer seminars and activities that promote academic success, hands-on aerospace relevant experiences, and career achievement. Prerequisite: freshman standing.

AE 460H. Selected Topics Honors (3).
Experiential based aerospace design course for honors students. Introduces basic Unmanned Air Vehicle (UAV) design methods, construction, and testing. Meets concurrently with and includes interactions with seniors enrolled in the AE 528 aerospace design class. Includes design, construction and testing of a small UAV. Prerequisites: admitted to honors program, sophomore or junior standing, aerospace engineering major.

AE 481A. Cooperative Education (1).
Introduces the student to engineering practice by working in industry in an engineering-related job and provides a planned professional experience designed to complement and enhance the student's academic program. Individualized programs must be formulated in consultation with, and approved by, appropriate faculty sponsors and cooperative education coordinators. Intended for students who will be working full time on their co-op assignment and need not be enrolled in any other course. Student may be able to use this course as a technical elective, with department consultation and permission prior to enrollment. Repeatable for credit. Prerequisites: junior standing and approval by the appropriate faculty sponsor.

AE 481I. Noncredit Internship (0).
Complements and enhances the student's academic program by providing an opportunity to apply and acquire knowledge in a workplace environment as an intern. Prerequisite: departmental consent.

AE 481N. Internship (1).
Complements and enhances the student's academic program by providing an opportunity to apply and acquire knowledge in a workplace environment as an intern. Prerequisite: departmental consent.

AE 481P. Cooperative Education (1).
Introduces the student to engineering practice by working in industry in an engineering-related job and provides a planned professional experience designed to complement and enhance the student's academic program. Individualized programs must be formulated in consultation with, and approved by, appropriate faculty sponsors and cooperative education coordinators. Students must enroll concurrently in a minimum of 6 credit hours of coursework including this course in addition to a minimum of 20 hours per week at their co-op assignment. Student may be able to use this course as a technical elective, with department consultation and permission prior to enrollment. Repeatable for credit. Prerequisites: junior standing and approval by the appropriate faculty sponsor.

AE 502. Aerospace Propulsion I (3).
Surveys aerospace propulsion methods. Production of thrust and consumption of fuel. Rocket performance analysis; liquid chemical and solid propellant rocket engines. Jet engine cycle analysis; turbojet, ramjet, turbofan and turboprop engines. Analyzes piston engines and propellers. Prerequisites: AE 227, 373, ME 398. Pre- or corequisite: AE 424.

AE 512. Experimental Methods in Aerospace (3).
Studies experimental methods and test planning, error analysis and propagation, model design, instrumentation and flow visualization. Uses electromechanical testing machines, subsonic and supersonic wind tunnels. Prerequisites: AE 333, 424. Pre- or corequisite: AE 524. Corequisite: AE 512L.

AE 514. Flight Dynamics and Control (3).
Static stability and control of conventional aircraft and implications in aircraft design, six degrees of freedom, time dependent equations of motion and their linearized solutions. Consideration of stability versus maneuverability and the dynamic modes of motion of the aircraft. Prerequisite: AE 415. Pre- or corequisite: AE 424.

AE 524. Aerodynamics II (3).
Continues the discussion of potential flow from AE 424. Introduces energy equation, fundamental concepts of high speed flow, normal and oblique shock waves, Prandtl-Meyer flow, nozzles and diffusers, linearized high speed potential flow, airfoils and wings in subsonic and supersonic flow, Navier-Stokes equation, boundary layer flow, momentum integral approximation and various laminar and turbulent flow solutions, introduction to convective heat transfer. Prerequisite: AE 424.

AE 525. Flight Structures I (3).
2 Classroom hours; 2 Lab hours. Introduces the theory of elasticity, advanced mechanics of materials, and stress analysis of flight vehicle components. Prerequisite: AE 333 (no grade lower than one that generates 2.000 or more credit points per credit hour will be accepted for this course). Pre- or corequisite: MATH 555. Corequisite: AE 525L.

AE 527. Numerical Methods in Engineering (3).
Error analysis. Includes polynomial approximations and power series, iterative solutions of equations, matrices and systems of linear equations, numerical differentiation and integration, approximate solution of differential equations by finite differences. Prerequisite: AE 227. Pre- or corequisite: MATH 555.

AE 528. Aerospace Design I (4).
2 Classroom hours; 4 Lab hours. Methodology of flight vehicle design; mission objectives, regulations and standards; use of hand and computer methods for configuration development and component sizing, ethics, and liability in design. Prerequisites: AE 502, 514, 525.

AE 607. Flight Control Systems (3).
Classical design methods for stability and control augmentation and guidance systems specifically for aerospace vehicles, including block diagrams, root locus and frequency response. Sensors used in aerospace systems. Flying qualities and performance specifications for closed loop systems. Includes a review of the aircraft and spacecraft dynamic model derivation. Prerequisite: AE 514.

AE 625. Flight Structures II (3).
2 Classroom hours; 3 Lab hours. Strength analysis and design of flight vehicle components. Introduces energy methods and variational principles. Applies finite element method, including commercial finite element software, to the analysis of flight vehicle structures. Prerequisite: AE 525. Corequisite: 625L.

AE 628. Aerospace Design II (4).
2 Classroom hours; 4 Lab hours. Preliminary design of flight vehicles, design iteration, sensitivity studies, optimization, economic considerations and introduction to project management. Prerequisite: AE 528.

AE 660. Selected Topics (1-3).
New or special topics presented on sufficient demand. Repeatable for credit when subject material warrants. Prerequisite: instructor's consent.

AE 690. Independent Study (1-3).
Arranged individual independent study in specialized areas of aerospace engineering under the supervision of a faculty member. Repeatable for credit. Prerequisite: consent of supervising faculty member.

AE 702. Aerospace Propulsion II (3).
In-depth study of rocket and jet propulsion. Turbojet and rocket engine components. Effect of operating variables on turbojet cycles and rocket performance. Prerequisite: AE 502 or instructor's consent.

AE 703. Rotor Aerodynamics (3).
Aerodynamics of rotors, including propellers, wind turbines and helicopters; momentum, blade element and potential flow analysis methods; helicopter dynamics, control and performance. Prerequisite: AE 424.

AE 707. Modern Flight Control System Design I (3).
Modern multi-loop design methods for stability and control augmentation and guidance systems, specifically for aerospace vehicles. State variable model. Optimal state feedback gains and Riccati's equation, tracking systems, sensors and actuator, discretization of continuous dynamic systems, optimal design for digital controls, and effect of nonlinearities and trim conditions on design considerations. Prerequisites: AE 514 or 714, and AE 607 or EE 684 or ME 659.

AE 711. Intermediate Aerodynamics (3).
Studies potential flow equations of motion, singularity solutions, principles of superposition, conformal mapping, thin airfoil theory, finite wing theory, three-dimensional singularities, swept wing theory, delta wing theory, and introduces panel methods. Prerequisite: AE 424 or equivalent.

AE 712. Advanced Aerodynamics Laboratory (3).
2 Classroom hours; 2 Lab hours. Advanced topics in wind tunnel testing, such as analysis and sensitivity, modeling techniques, flexure design and calibration, control surface loads and moments, laser velocimetry, hot film anemometry, dynamic signal processing, flow measurement probes, flow visualization using smoke tunnels and water tunnel. Prerequisite: AE 512.

AE 714. Advanced Flight Dynamics I (3).
Detailed derivation of the linear and nonlinear equations of motion for aircraft. Aerodynamic and thrust force and moment models. Steady state flight and dynamic stability and control of aircraft. Aircraft, FAR and MIL specs. Prerequisite: AE 514.

AE 715. Intermediate Space Dynamics (3).
Advanced topics in orbital mechanics-vector mechanics perspective of the two-body problem; fast transfers; interplanetary missions including gravity assist maneuver and intercept problem; atmospheric entry. Prerequisite: AE 415 or instructor's consent.

AE 716. Compressible Fluid Flow (3).
Analyzes compressible fluid flow for one- and two-dimensional cases, moving shock waves, one-dimensional flow with friction and heat addition, linearized potential equation, method of characteristics, conical shocks and subsonic similarity laws. Prerequisites: AE 424, ME 521 or equivalent.

AE 719. Introduction to Computational Fluid Dynamics (3).
Classification of partial differential equations, numerical solution of parabolic, elliptic and hyperbolic differential equations, stability analysis, boundary conditions, scalar representation of the Navier-Stokes equations, incompressible Navier-Stokes equations. Prerequisite: AE 424 or ME 521.

AE 721. Aircraft Icing (3).
Topics include the icing environment, icing envelopes, ice accretion physics, fundamental equations for icing analysis, types of ice accretions, effects of ice accretions on aircraft aerodynamic performance, ice protection and detection systems, icing test facilities, introduces simulation tools for aircraft icing analysis, icing incidents and accidents, and aspects of aircraft icing certification. Corequisite: AE 424 or equivalent.

AE 722. Finite Element Analysis of Structures I (3).
Advanced treatment of the theoretical concepts and principles necessary for the application of the finite element method in the solution of differential equations in engineering. Prerequisite: AE 525 or AE 733.

AE 731. Theory of Elasticity (3).
Develops the equations of the theory of elasticity and uses them to determine stress and displacement fields in linear elastic isotropic bodies; uses Airy stress functions to obtain solutions. Prerequisite: AE 525 or AE 733.

AE 733. Advanced Mechanics of Materials (3).
Extension of AE 333. Includes transformation of stress and strain in three dimensions, torsion of members with noncircular cross sections, curved beams, beams with unsymmetrical cross sections, energy methods, stress concentrations, and theories of failure and fracture mechanics. Prerequisite: AE 333.

AE 737. Mechanics of Damage Tolerance (3).
Introduces fatigue analysis and mechanics of damage tolerance emphasizing stress analysis oriented fracture mechanics. Includes stress intensity, fracture toughness, residual strength, fatigue crack growth rate, fatigue crack propagation, and damage tolerance concepts. Prerequisite: AE 525 or AE 733.

AE 753. Mechanics of Laminated Composites (3).
Descriptive classification of advanced composite materials and their constituents; mechanics of lamina and laminates, testing for material properties, lamina and laminate failure criteria, laminate strain allowables, structural analysis (beams and axially loaded members), design guidelines, introduction to manufacturing methods, repair and nondestructive testing. Prerequisite: AE 525, or AE 733, or equivalent.

AE 759. Neural Networks for System Modeling and Control (3).
Introduces specific neural network architectures used for dynamic system modeling and intelligent control. Includes theory of feed-forward, recurrent, and Hopfield networks; applications in robotics, aircraft and vehicle guidance, chemical processes and optimal control. Prerequisite: AE 607 or ME 659 or EE 684 or instructor's consent.

AE 760. Selected Topics (1-3).
Prerequisite: instructor's consent.

AE 760AA. Micromechanics and Multi-Scale Modeling (3).
Many materials and structures consist of multiple phases. Micromechanics models can be used to homogenize a structure at some appropriate scale for more practical modeling. Course covers the classical mean-field homogenization models. Explores several state-of-the-art numerical techniques used in micromechanics modeling, such as the method of cells, variational methods and Fourier transforms in addition to finite element techniques for periodicity.

AE 760AB. Structural Acoustics (3).
Introduces the basic concepts of engineering acoustical analysis to study wave propagation, sound radiation from simple sources, absorption and transmission of acoustic wave through partitions, duct acoustics, aircraft noise sources and control techniques.

AE 760AC. Nano-satellite Engineering (3).
Provides a fundamental understanding of the design of a nano-satellite and mission design catering to given mission requirements. Covers nano-satellite mission analysis, attitude control, electrical power systems, propulsion subsystem, thermal system, telemetry, data handling/processing and systems engineering tests. Includes hands-on experimentation using nano-satellite educational kits.

AE 760AD. Applied Jet Propulsion (3).
In-depth overview of jet propulsion. Effect of operating variables on turbojet and modified engine cycles. Introduces real world issues and engine testing.

AE 760AE. Applied Jet Propulsion Subsystems (3).
In-depth study of jet engine components. Introduction to engine component manufacturing, maintenance, and repair issues. Prerequisite: AE 502 or instructor's consent.

AE 760AF. Experimental Vibration Analysis (3).
Covers all basic aspects of experimental vibration analysis including modal analysis theory, digital signal processing and experimental modal model development. Includes hands-on vibration testing labs and a basic overview of finite element modeling of dynamic systems and model correlation. Prerequisites: AE 777, AE 333 or equivalent; MATH 511 or equivalent, and MATH 555 or equivalent.

AE 760AG. Structural Dynamics and Acoustics (3).
Studies the dynamic response of continuous structural systems subjected to external dynamic forcing functions. Introduces the basic concepts of engineering acoustical analysis to study sound propagation in a medium, acoustic radiation from simple sources, and absorption and transmission of acoustic waves through partitions. Prerequisites: AE 777, MATH 555 or equivalent.

AE 765A. Special Topics - Composite Manufacturing: Technology Safety Awareness I (0.5).
Provides composite materials technologies basic knowledge, an overview of different forms of composites manufacturing, various factory workflows, and the associated regulatory guidance documents. For graduate students only. Repeatable for credit.

AE 765B. Special Topics - Composite Manufacturing: Technology Safety Awareness II (0.5).
Educates students on the issues related to raw material manufacturing, its transport, incoming quality control and storage of composite materials. The preparation of tooling, cutting of composite preforms, layup and bagging of composite parts, and curing are discussed in detail. The use of procurement specifications and process control documents are emphasized. For graduate students only. Repeatable for credit. Prerequisite: AE 765A.

AE 765C. Special Topics - Composite Manufacturing: Technology Safety Awareness III (0.5).
Topics include technical aspects related to trimming and drilling of composites, defects in composites, adhesive bonding and assembly, nondestructive and destructive inspection. For graduate students only. Repeatable for credit. Prerequisite: AE 765B.

AE 765D. Special Topics - Composite Manufacturing: Technology Safety Awareness IV (0.5).
Topics include technical aspects related to painting and finishing composites, handling and storage, manufacturing defects and their root causes analyses, and scarf repair of composites. For graduate students only. Repeatable for credit. Prerequisite: AE 765C.

AE 765E. Special Topics - Composite Manufacturing: Technology Safety Awareness V (0.5).
Lab course providing students with hands-on experiences on prepreg cutting, manual layup and bagging of simple laminated composite parts, nondestructive inspection, and scarf repair. For graduate students only. Repeatable for credit. Prerequisite: AE 765D.

AE 765F. Composite Structural Engineering Technology-0 (0.5).
Provides students with background knowledge related to composite material applications, materials, processes, manufacturing, structural design, proof of structures, maintenance, aeroelastic issues, crashworthiness, fire safety and lightening protection. Course serves as

a foundation course for the follow-on courses which elaborate on the aforementioned topics. Prerequisite: instructor's consent.

AE 765G. Composite Structural Engineering Technology-1 (0.5).
Provides a historical overview of composites usage in aircraft structures; discusses the key technical characteristics of composite structures; composites safety and certification initiatives by FAA; issues affecting cost of incorporating composites; role of standards organizations; some evolving composite technologies; evolution and objectives of integrated product teams. Pre- or corerequisite: AE 765F.

AE 765P. Composites Structural Integrity and Repair (0.75).
Exposes students to various aspects of composite manufacturing, inspections, repair and testing. Includes fabrication of monolithic and sandwich panels, joining composites with adhesive bonding, inspecting composites with various nondestructive techniques, machining and hole drilling repair of composite structures (monolithic and honeycomb), instrumentation of composite test articles, and various aspects of mechanical testing of composite structures. Designed as a supplemental course for composite theory classes, thus lab time is maximized so that the students get hands-on experience. Prerequisite: instructor's consent.

AE 765Q. Structural Integrity and Repair of Metallic Airframe Structures (0.75).
Provides students with hands-on experience in the structural testing and evaluation of stiffened metallic panels. Students learn the hole drilling methods and use a CNC machine to drill holes and assemble a stiffened picture frame shear specimen. The hands-on experience includes nondestructive inspection of damaged stiffened panels using eddy current, mag. particles, dye penetrant, pulse thermography and X-ray methods. Students install strain gages and crack gages on picture frame shear test article which is tested on a servo hydraulic testing machine. Students are exposed to the basic principles of testing, analysis of test data, and failure analysis using SEM and optical microscope. Prerequisite: instructor's consent.

AE 770BA. Badge: Composite Manufacturing Technology Safety Awareness I (0.5).
Students are provided with composite materials technologies basic knowledge, an overview of different forms of composites manufacturing, various factory workflows, and the associated regulatory guidance documents. Graded Bg/NBg.

AE 770BB. Badge: Composite Manufacturing Technology Safety Awareness II (0.5).
Educates students on the issues related to raw material manufacturing, its transport, incoming quality control and storage of composite materials. The preparation of tooling, cutting of composite preforms, layup and bagging of composite parts, and curing are discussed in detail. The use of procurement specifications and process control documents are emphasized. Graded Bg/NBg. Prerequisite: AE 770BA.

AE 770BC. Badge: Composite Manufacturing Technology Safety Awareness III (0.5).
Topics include technical aspects related to trimming and drilling of composites, defects in composites, adhesive bonding and assembly, nondestructive and destructive inspection. Graded Bg/NBg. Prerequisite: AE 770BB.

AE 770BD. Badge: Composite Manufacturing Technology Safety Awareness IV (0.5).
Topics include technical aspects related to painting and finishing of composites, handling and storage, manufacturing defects and their root cause analysis, and scarf repair of composites. Graded Bg/NBg. Prerequisite: AE 770BC.

AE 770BE. Badge: Composite Manufacturing Technology Safety Awareness V (0.5).
Lab course provides students with hands-on experience on prepreg cutting, manual layup and bagging of simple laminated composite parts, nondestructive inspection and scarf repair. Graded Bg/NBg. Prerequisite: AE 770BD or instructor's consent.

AE 770BF. Badge: Advanced MATLAB (0.5).
Review of programming basics, ordinary differential equation solvers, optimization solvers, control system toolbox, animation, file-based input/output, Matlab interaction with other programming languages (C/C++). Graded Bg/NBg.

AE 770BG. Badge: Composite Structural Engineering Technology-0 (0.5).
Provides students with background knowledge related to composite material applications, materials, processes, manufacturing, structural design, proof of structures, maintenance, aeroelastic issues, crashworthiness, fire safety and lightening protection. Course serves as a foundation course for the follow-on courses which elaborate on the aforementioned topics. Graded Bg/NBg. Prerequisite: instructor's consent.

AE 770BI. Badge: Composite Structural Engineering Technology-1 (0.5).
Historical overview of composites usage in aircraft structures; discusses the key technical characteristics of composite structures; composites safety and certification initiatives by FAA; issues affecting cost of incorporating composites; role of standards organizations; some evolving composite technologies; evolution and objectives of integrated product teams. Graded Bg/NBg. Pre- or corequisite: AE 770BG.

AE 773. Intermediate Dynamics (3).
Extension of AE 373. Studies the kinematics and kinetics of particles and rigid bodies for two- and three-dimensional motion. Includes an introduction to vibratory motion, dynamic stability of linear systems and Lagrange's equations. Prerequisite: AE 373.

AE 777. Vibration Analysis (3).
Studies free, forced, damped and undamped vibrations on multi-degree of freedom discrete mechanical systems. Introduces vibration analysis of continuous solids. Prerequisites: MATH 555, AE 333, 373.