

Aerospace Engineering (AERO)

AERO 502 Strength and Fatigue of Materials 3 Credits (3,0)

Stress and deformation analysis in rods, beams, plates, shells, and solids using elementary theories of elasticity and plasticity; theories of strength, impact fatigue, creep; computer methods and applications.

Course Offered at: Daytona Beach, Worldwide

AERO 504 Advanced Compressible Flow 3 Credits (3,0)

Compressible flow problems; basic conservation laws; wave phenomena; normal and oblique shocks; method of characteristics; wave interactions; perturbation theories; similarity rules; linearized supersonic flow; axisymmetric flow wing theory; wave drag; nonlinear theories of transonic and supersonic flows.

Course Offered at: Daytona Beach

AERO 506 Airplane Dynamic Stability 3 Credits (3,0)

Small-disturbance theory; linearized solutions of general motion equations; aerodynamic derivatives; stability of uncontrolled longitudinal and lateral motions; computer solutions; automatic stability and control; flight control system analysis.

Course Offered at: Daytona Beach

AERO 507 Design, Build and Test 3 Credits (3,0)

Complete design cycle from idea conception to implementation and testing; design, build, and test an experimental system; exposure to design, building, and testing tools and practices; critical design review process; comprehensive final report and presentation.

Course Offered at: Daytona Beach

AERO 508 Intermediate Heat Transfer 3 Credits (3,0)

Analytical and numerical methods in conduction, convection, radiation, and combined-mode heat transfer; one-, two-, and three-dimensional problems; steady state and transient solutions; boundary conditions; energy balances.

Course Offered at: Daytona Beach

AERO 510 Aircraft Structural Dynamics 3 Credits (3,0)

Vibrations of deformable elastic structures using the assumed modes method; analysis of continuous systems; undamped and damped free and forced vibration of single-degree-of-freedom and multiple-degree-of-freedom systems; computer programming skills necessary.

Course Offered at: Daytona Beach, Worldwide

AERO 511 Engineering Materials Selection 3 Credits (3,0)

Mechanical behavior of aerospace materials; methods for strengthening metals, ceramics, composites; materials selection using functions, constraints, objectives; Ashby materials property charts; hybrid materials design; aerospace engineering case studies; course project.

Course Offered at: Daytona Beach, Worldwide

AERO 512 Combustion I 3 Credits (3,0)

Equilibrium and kinetics of combustion processes; law of mass action; Arrhenius reaction rate law; heat of reaction; adiabatic flame temperature; conservation equations of reacting flows; applications of conservation equations.

Course Offered at: Daytona Beach

AERO 515 Introduction to the Finite Element Method 3 Credits (3,0)

Basic equations of the theory of elasticity; energy principles; formulation and assembly of stiffness matrices and load vectors for elastic solids; modeling considerations; solution methods; computer implementation of finite element and stress analysis procedures; interpretation of computer solutions; design applications.

Course Offered at: Daytona Beach, Worldwide

AERO 516 Computational Aeronautical Fluid Dynamics 3 Credits (3,0)

Fundamental theory and application of modern computational fluid dynamics for aerodynamics; governing and model equations; nature of PDEs; finite-difference approximation; stability analysis; explicit and implicit solver techniques; finite-volume approximation; coding exercises; best practices in CFD grid generation and modeling for aerospace applications.

Course Offered at: Daytona Beach

AERO 520 Perturbation Methods in Engineering 3 Credits (3,0)

Gauge functions; asymptotic expansions; singular perturbation problems; straining parameters; method of multiple scales; evaluation of self-excited systems; Duffing equation; Mathieu equation; boundary-layer problems; gyroscopic problems.

Course Offered at: Daytona Beach

AERO 521 Viscous Flow 3 Credits (3,0)

Navier-Stokes equations for laminar and turbulent flows; boundary layers; jets; wakes; elementary turbulence modeling; skin friction; separation; drag; aerodynamic heating; approximate and exact finite-difference solutions; effects of suction and blowing; solutions of turbulent boundary layer equations.

Course Offered at: Daytona Beach

AERO 522 Analysis of Aircraft Composite Materials 3 Credits (3,0)

Fiber materials; elastic anisotropic materials; elastic constants; matrix formulation; computer analysis; strength and failure theory; experimental data use; design considerations.

Course Offered at: Daytona Beach, Worldwide

AERO 523 Linear Systems 3 Credits (3,0)

Fundamentals of linear systems theory; simulation of free and controlled responses of linear dynamical systems; state space representations; linearization of nonlinear systems; linear vector spaces; norms and inner products; solution of linear time-invariant systems; matrix exponential; stability of linear time-invariant systems; eigenvalues and eigenvectors; coordinate transformations; Laplace transforms and transfer functions; controllability and observability; Kalman decompositions; MATLAB used for simulation and analysis.

Course Offered at: Daytona Beach

AERO 524 Rocket Engine Propulsion Systems 3 Credits (3,0)

Combustion and expansion processes analysis; thrust nozzle performance analysis and design techniques; characteristics of liquid propellants and liquid propellant rocket motors; characteristics of solid propellants and interior ballistics of solid propellant rocket motors; cooling techniques; thrust vector control methods.

Course Offered at: Daytona Beach

AERO 525 Structural Design Optimization 3 Credits (3,0)

Review of numerical optimization techniques; structural applications of linear and discrete methods; approximation techniques; sensitivity analysis; shape and topology optimization; optimality criteria methods; applications to trusses, frames, and composite laminates; optimization simulations using computer graphics software; emphasis on modern optimization techniques linked to numerical methods of structural analysis finite element method through a structural design course project.

Course Offered at: Daytona Beach, Worldwide

AERO 526 Engineering Optimization 3 Credits (3,0)

Numerical optimization methods applied to engineering problems; constrained problems and Kuhn-Tucker conditions; optimization model construction; sequential unconstrained optimization; direct methods for constrained problems; structural optimization; genetic algorithms; simulated annealing methods; applications in research and engineering; case studies in mechanical and aerospace engineering.

Course Offered at: Daytona Beach, Prescott

AERO 527 Modern Control Systems 3 Credits (3,0)

Modern control theory using continuous time state-space system models and implementations; state space representation; controllability; observability; stability; control structures such as PID and state feedback controllers; continuous to discrete time conversions; z-transform; advanced topics like model predictive control, adaptive control, robust control, Kalman filters.

Course Offered at: Daytona Beach

AERO 528 Advanced Incompressible Aerodynamics 3 Credits (3,0)

Reynolds transport equation and the governing equations of incompressible fluid motion in Eulerian and Lagrangian forms with applications. Potential flow theory and elementary flows. Steady and quasi-steady thin airfoil theory with applications. Conformal mapping and Joukowski airfoils. Lifting-line and finite wing theory. Surface singularity (panel) methods for non-lifting and lifting bodies. Boundary layers, boundary layer equations, and Blasius solution. Classical unsteady aerodynamics in the frequency and time domain, including Theodorsen's theory, indicial methods, Wagner and Sear's problems, and an introduction to flutter.

Course Offered at: Daytona Beach

AERO 531 Orbital Mechanics 3 Credits (3,0)

Fundamentals of two-body motion; conic sections; Kepler's laws; integrals of motion; universal variables formulation; orbital maneuvers; rigorous modeling of orbit prediction through analytical and numerical methods; spacecraft orbits under gravitational, aerodynamic, and other perturbing forces; perturbation theory; variation of parameters; Lagrange's planetary equations; applications to rendezvous and space navigation.

Course Offered at: Daytona Beach

AERO 532 Engineering Materials and Failure Analysis 3 Credits (3,0)

Overview of engineering materials: structure, properties, and processing; Different failure mechanisms: fracture, fatigue, and creep; Design and manufacturing recommendations; Emphasis on structural materials used in the aerospace industry.

Course Offered at: Daytona Beach

AERO 534 Smart Materials in Engineering 3 Credits (3,0)

General area of smart materials used for aerospace structures; current research in material development; diverse applications; design; modeling; control; smart actuators and sensors; types of smart materials including piezoelectric, active fiber composites, electrostrictive, magnetostrictive, electroactive polymers, shape memory alloys, electro and magnetorheological fluids, optical fibers.

Course Offered at: Daytona Beach

AERO 536 Rotorcraft Aerodynamics 3 Credits (3,0)

Introduction to Vertical Take-Off and Landing (VTOL) concepts and configurations; rotor kinematics; momentum and blade element theory; rotor wakes and noise; airfoil design for rotorcraft; introduction to CFD techniques; rotorcraft performance and design.

Course Offered at: Daytona Beach

AERO 538 Theory of Elasticity 3 Credits (3,0)

Theory of elasticity as a branch of continuum mechanics; linear stress and strain analysis; constitutive equations; boundary conditions; compatibility equations; plane stress and strain problems; Airy stress function method; two-dimensional problems in various coordinate systems; thermal stress in plates and thick-wall cylinders; stress and strain analysis of three-dimensional problems; torsion of prismatic bars; introduction to theory of plasticity.

Course Offered at: Daytona Beach

AERO 540 Structural Health Monitoring 3 Credits (3,0)

General introduction to structural health monitoring and non-destructive evaluation techniques for mechanical and aerospace structural components; passive and active damage analysis through intelligent actuation and sensing systems; damage detection, diagnosis, and prognosis using signal processing techniques and physics-based approaches.

Course Offered at: Daytona Beach, Worldwide

AERO 542 Mechanics of Structures: Variational and Computational Methods 3 Credits (3,0)

Energy and variational principles in applied mechanics; fundamental theorems from variational calculus and solid mechanics; derivation of mechanics equations from energy and variational principles (virtual work principles); approximate solution to problems in structural mechanics (bars, beams, plates, composite laminates) using variational methods.

Course Offered at: Daytona Beach

AERO 544 Analytical Dynamics 3 Credits (3,0)

Relevant rigid body kinematics and dynamics for aircraft and spacecraft; foundation for advanced dynamics and controls courses; research on dynamics and control of vehicle systems; particle motion; Newton's laws; rigid body dynamics; methods of analytical dynamics; application to spacecraft orbital mechanics and aircraft performance; rigorous modeling of rotational and translational motion of rigid and lightly flexible bodies.

Course Offered at: Daytona Beach

AERO 550 Thermodynamics: Classic and Modern Perspectives 3 Credits (3,0)

Development of classical thermodynamics from postulates to macroscopic thermodynamics and thermodynamic properties; kinetic theory; development of classical thermodynamic relations using Maxwell's velocity distribution; introduction to chemical thermodynamics, equilibrium, and kinetics; development of modern thermodynamics from a microscopic perspective using quantum mechanics and statistical mechanics; tools to analyze high-temperature flows (e.g., hypersonic applications).

Course Offered at: Daytona Beach

AERO 552 Unconventional Aircraft Design 3 Credits (3,0)

Conceptual and preliminary design of advanced and unconventional aircraft concepts; design of specialized aircraft (e.g., flying wings, blended-wing-bodies, canards, flying planks, tandem wings, box wings, stealth, electric, seaplanes); advanced methods in performance and stability and control; initial structural layout; lifecycle-cost analysis; certification compliance plans; mission-tailored airfoil design; flight control systems; optimization methodologies; preparation of a complete aerodynamic model for flight simulation; engineering ethics; investigation of failures in engineering design. Solid modeling software required.

Course Offered at: Daytona Beach

AERO 553 Hybrid and Urban Air Mobility 3 Credits (3,0)

Technologies required for hybrid and Urban Air Mobility Aircraft; enabling attributes of electrified propulsion for quieter, less emission-producing, or lower direct operating cost aircraft; overarching design space physics; details of particular clusters of promising solutions; thin haul parallel hybrid architectures; serial multi-rotors; technologies enabling these advances.

Course Offered at: Daytona Beach

AERO 554 Applied Engineering Analysis 3 Credits (3,0)

Step-by-step engineering problem solving using applied mathematics; overview of engineering analysis for graduate students in AE, ME, CE; mathematical modeling of real-world problems; significant calculus applications; review of linear algebra, vector algebra, ODEs, PDEs, Laplace transformations, Fourier series; introduction to finite element method (FEM); applied numerical methods; real-world problems in solid mechanics, fluid mechanics, structures, aerodynamics, heat transfer, and vibration. Focus on practical engineering applications, not just math.

Course Offered at: Daytona Beach

AERO 596 Graduate Internship in Aerospace Engineering 1-3 Credit (3,0)

Temporary professional or industrial work appointments available to students enrolled in graduate programs; opportunity to extend academic endeavors through the application of theories and philosophies studied in the classroom to professional activities common to the workplace; academic-professional activities coordinated by the university between offering organizations and graduate student.

Course Offered at: Daytona Beach

AERO 599 Special Topics in Aerospace Engineering 1-6 Credit (1-6,0)

Individual, independent or directed studies of selected topics in aerospace engineering.

Course Offered at: Daytona Beach, Prescott, Worldwide

AERO 606 Finite Element Aerospace Applications 3 Credits (3,0)

Development of finite element representation of continuum using Galerkin and variational techniques; boundary elements; applications to statics and dynamics of solids, structures, fluids, and heat flow; use of finite element codes.

Course Offered at: Daytona Beach

AERO 610 Advanced Computational Fluid Dynamics 3 Credits (3,0)

Advanced theory and application of modern computational fluid dynamics for aerodynamics; review of Navier-Stokes equations; advanced high-order flux schemes (MacCormack, DRP, Compact, HLLC, WENO); nonreflective boundary conditions; turbulence modeling; end-of-semester project using OpenFOAM or similar solver.

Course Offered at: Daytona Beach

AERO 612 Analysis of Aircraft Plate and Shell Structures 3 Credits (3,0)

Bending and buckling of plates; cylindrical bending; boundary value problems; deformation of shells; energy principles; stress and stability analysis; approximate methods; finite element methods; computer applications.

Course Offered at: Daytona Beach, Worldwide

AERO 615 Advanced Topics in Fatigue and Damage Tolerance 3 Credits (3,0)

Stress-based fatigue and Miner's rule. Strain-based approach for fatigue. Linear elastic and elastic-plastic fracture mechanics, spectra survey and exceedance diagrams. Fatigue crack growth, damage tolerance assessment, non-destructive inspections and structural reliability. Fractography, prediction and prevention. Crack growth simulation, statistical analysis codes, and scanning electron microscope (SEM) for mechanism characterization.

Course Offered at: Daytona Beach

AERO 616 Advanced Aircraft Structural Dynamics 3 Credits (3,0)

Analysis of structures subjected to dynamic loads; Hamilton's principle; Lagrange's equations; Rayleigh's principle; numerical evaluation of natural frequencies and modes; mode superposition and direct integration methods for dynamic response; finite element modeling; component mode synthesis; computer applications.

Course Offered at: Daytona Beach

AERO 618 Aeroelasticity 3 Credits (3,0)

Fundamentals of aeroelasticity; interaction between elastic, inertial, and aerodynamic forces with emphasis on aeronautical applications; theoretical and computational foundations of structural dynamics, aerodynamics, static and dynamic aeroelasticity; related performance issues such as flutter, control effectiveness, divergence.

Prerequisites: AERO 510

Course Offered at: Daytona Beach

AERO 623 Navigation, Guidance and Control 3 Credits (3,0)

Theory and application of automatic flight controls, navigation, and guidance; sensor fusion; state estimation; nonlinear and adaptive control laws; path planning techniques; application to uncrewed aerial robotic systems.

Prerequisites: AERO 527

Course Offered at: Daytona Beach

AERO 625 Hypersonic Aerospace Propulsive Flows 3 Credits (3,0)

Aerodynamic and propulsive flows associated with hypersonic vehicles; hypersonic inviscid flow approximations; viscous effects; high-temperature chemical and thermodynamic effects; rocket plumes; scramjets; experimental facilities; best practices in numerical simulation; projects emphasizing analytical approximations and computational fluid dynamic simulation.

Course Offered at: Daytona Beach

AERO 626 Advanced Topics in Discrete Control Theory 3 Credits (3,0)

Linear and nonlinear discrete control; sampling and quantization; Z-transform; Z-domain control analysis; adaptive discrete control for fault tolerance; estimation and compensation of disturbances.

Prerequisites: AERO 527

Course Offered at: Daytona Beach

AERO 627 Adaptive Control 3 Credits (3,0)

Fundamentals of adaptive control theory; stability of uncertain linear/nonlinear, time-invariant and time-varying dynamical systems using Lyapunov system theory; uncertain systems and parameter estimation algorithms; direct/indirect adaptive controllers; model reference adaptive control; related simulations using MATLAB.

Prerequisites: AERO 523 or AERO 527 or permission from the instructor

Course Offered at: Daytona Beach

AERO 629 Robust Control Systems 3 Credits (3,0)

Advanced course on multivariable feedback control; multivariable frequency response analysis; relative gain array (RGA) and interpretation; multiple-input multiple-output (MIMO) robustness; formulation of general control problem; control of multivariable plants; robust stability and performance analysis for MIMO systems; H₂ and H-infinity control designs; model and controller reduction applied to practical examples.

Prerequisites: AERO 523

Course Offered at: Daytona Beach

AERO 631 Aeroacoustics 3 Credits (3,0)

Sound and wave characteristics; levels and directives; hearing and physiological effects of noise; noise control criteria and regulations; instrumentation; acoustic materials and structures; aircraft components; acoustic analogy; computational aeroacoustics.

Course Offered at: Daytona Beach

AERO 633 Optimal Control 3 Credits (3,0)

Basic optimization methods and fundamental principles of optimal control; deterministic and stochastic problems for both continuous and discrete-time systems with state and control constraints; solution methods (numerical search algorithms, dynamic programming, calculus of variations, Pontryagin's maximum principle, model predictive control); applications to aerospace, mechanical, and electrical systems.

Course Offered at: Daytona Beach

AERO 635 Flow Stability and Control 3 Credits (3,0)

Scope of flow instabilities; Kelvin-Helmholtz instability; Tollmien-Schlichting waves; Rayleigh-Taylor instability; other flow instabilities; actuators and sensors; passive and active control methods; numerical simulations; control of boundary layers and free shear flows.

Prerequisites: AERO 521

Course Offered at: Daytona Beach

AERO 640 Turbine Engine Propulsion Systems 3 Credits (3,0)

Advanced theory of turbojet, multispool fan jet, variable cycle engines, and bypass air-breathing propulsion systems; design and off-design performance analysis; theory and design of inlets, compressors, burners, and turbines; component matching; cooling; regenerative systems; test methods; corrections; engine post-stall behavior.

Course Offered at: Daytona Beach

AERO 646 Nonlinear Systems 3 Credits (3,0)

Stability and behavior of continuous nonlinear systems; review of linear systems theory; phase plane analysis; Lyapunov stability theory; introduction to discrete-time systems; metric spaces and contraction mappings; bifurcations and chaos; nonlinear control methods; applications to aerospace systems.

Course Offered at: Daytona Beach

AERO 648 Thermal Stresses in Aerospace Engineering 3 Credits (3,0)

Basic equations of thermoelasticity; thermal structures problems (rods, beams, plates); thermally induced vibration; thermal buckling; thermoviscoplasticity.

Course Offered at: Daytona Beach

AERO 652 Turbulent Flows 3 Credits (3,0)

Stability of laminar flows; spectral methods for predicting flow stability, transition, and turbulence; amplification of unstable modes; transition to turbulence; statistical description of turbulent flows; Reynolds decomposition; Reynolds equations applied to free shear flows (jet, mixing layer, wake); scales of turbulent motion; energy cascade; Kolmogorov theory; wall-bounded flows (boundary layer); direct numerical simulation (DNS); large eddy simulation (LES); Reynolds-averaged Navier-Stokes (RANS) equations; turbulence models; transition modeling for RANS simulations.

Course Offered at: Daytona Beach

AERO 654 Geometric Mechanics and Control of Rigid Body Motions 3 Credits (3,0)

Fundamentals of groups, fields, and vector spaces; fundamentals of differential geometry including Lie groups, tangent bundles, Lie algebras, exponential map; classical mechanics (Newtonian, Eulerian); dynamic modeling in geometric mechanics framework accounting for translation-rotation couplings in body motions; Lagrangian and Hamiltonian developments; variational integrators; Lyapunov-based geometric theory of nonlinear control; Morse-Lyapunov stability analysis of rigid body motions; applications to formation flight, consensus of rigid bodies, multiple-DOF systems.

Prerequisites: AERO 544

Course Offered at: Daytona Beach

AERO 678 Estimation of Dynamic Systems 3 Credits (3,0)

Introduction to linear and nonlinear estimation methods related to modern dynamic systems in aerospace disciplines; emphasis on theory and application; batch and sequential strategies; real-time estimation; parameter estimation; state estimation; least squares estimation; nonlinear filtering methods.

Prerequisites: AERO 544

Course Offered at: Daytona Beach

AERO 699 Special Topics in Aerospace Engineering 1-6 Credit (1-6,0)

Individual, independent or directed studies of selected topics in aerospace engineering.

Course Offered at: Daytona Beach, Prescott, Worldwide

AERO 700 Graduate Thesis 1-9 Credit (1-9,0)

A master-level research project in Aerospace Engineering conducted under the supervision of the student's advisor and thesis committee. Submission of a final report, approved by the thesis committee, and an oral defense of the research work are required for thesis credits to be earned.

Course Offered at: Daytona Beach

AERO 800 Dissertation 1-9 Credit (1-9,0)

Doctoral-level research in Aerospace Engineering; oral defense and written dissertation satisfying all doctoral degree program guidelines; work supervised by the student's advisor and dissertation committee; approval of dissertation committee required for final dissertation credit.

Course Offered at: Daytona Beach