UNDERGRDAUATE COURSES

Fluid Dynamics

AE 2110 Introduction to Incompressible Fluid Dynamics
AE 3110 Fundamentals of Compressible Fluid Dynamics
AE 3120 Fundamentals of Aerodynamics

Propulsion and Energy

AE 4210 Fundamentals of Air-breathing Propulsion
AE 4220 Fundamentals of Rocket Propulsion

Flight Dynamics and Control

AE 2310 Introduction to Aerospace Control Systems
AE 2320 Introduction to Orbital Mechanics
AE 3310 Fundamentals of Navigation and Communication
AE 4310 Fundamentals of Aircraft Dynamics and Control
AE 4320 Fundamentals of Spacecraft Dynamics and Control

Materials and Structures

AE 2410 Introduction to Aerospace Structures
AE 3420 Fundamentals of Aerospace Structures
AE 3430 Fundamentals of Composite Materials
AE 4410 Fundamentals of Structural Dynamics

Aerospace Design

AE 4510 Aircraft Design
AE 4520 Spacecraft and Mission Design

GRADUATE COURSES

Fluid Dynamics

AE 5131. Incompressible Fluid Dynamics (2 credits)
AE 5132. Compressible Fluid Dynamics (2 credits)
AE 5133. Kinetic Theory of Gases and Applications (2 credits)
AE 5134. Plasma Dynamics (2 credits)

Propulsion and Energy

AE 5231. Air Breathing Propulsion (2 credits)
AE 5232. Spacecraft Propulsion (2 credits)
AE 5233. Combustion (2 credits)
AE 5234. Renewable Energy (2 credits)

Flight Dynamics and Controls

AE 5331. Linear Control Systems (2 credits)
AE 5332. Nonlinear Control Systems (2 credits)
AE 5333. Optimal Control for Aerospace Applications (2 credits)
AE 5334. Spacecraft Dynamics and Control (2 credits)
AE 5335. Autonomous Aerial Vehicles (2 credits)

Materials and Structures

AE 5431. Solid Mechanics for Aerospace Structures (2 credits)
AE 5432. Composite Materials (2 credits)
AE 5433. Aeroelasticity (2 credits)
AE 5434. Computational Solid Mechanics (2 credits)
AE 5435. Fracture Mechanics (2 credits)

General Aerospace Engineering Topics

AE 5031. Applied Computational Methods for Partial Differential Equations (2 credits)
AE 5032. Aerospace Engineering Seminar (0 credits)

AE Research Courses
AE 5098. Directed Research (credits TBD)
AE 5900. Graduate Internship Experience (1-3 credits)
AE 6900. Graduate Internship Experience (1-3 credits)
AE 6098. Pre-Dissertation Research (credits TBD)
AE 6099. Dissertation Research (credits TBD)

Fluid Dynamics

AE 2110 Introduction to Incompressible Fluid Dynamics
This course covers the fundamentals of inviscid and viscous incompressible fluid dynamics. Topics presented will be considered from the following: fluid kinematics and deformation; integral conservation laws of mass, momentum and energy for finite systems and control volumes; differential conservation laws of mass, momentum and energy; the Navier-Stokes equations; the streamfunction and the velocity potential. Applications will be considered from the following topics: hydrostatics; incompressible, inviscid, irrotational (potential) flows; incompressible boundary layer flows; viscous incompressible steady internal and external flows; and dimensional analysis. Students may not receive credit for both AE 2110 and AE 3602.
Units: 1/3
Category:
Category I
Recommended Background:
differential equations (MA2051 or equivalent), dynamics (ES 2503, PH 2101 or equivalent), thermodynamics (ES 3001, PH 2101, CH 3510 or equivalent).

AE 3110 Fundamentals of Compressible Fluid Dynamics
In this course, students are introduced to various compressibility phenomena such as compression (shock) and expansion waves. Conservation laws and thermodynamic principles are applied to the description of flows in which compressibility effects are significant. One-dimensional models are applied to analysis of flow in variable area ducts, normal and oblique shock waves, expansion waves, and flows with friction and heat addition. Numerous applications from engineering are investigated including supersonic inlets, rocket nozzles, supersonic wind tunnels, gas delivery systems, and afterburning jet engines. Students may not receive credit for both AE 3110 and AE 3410.

Units: 1/3
Category:
Category I
Recommended Background:
thermodynamics (ES 3001, CH 3510 or equivalent), incompressible fluid dynamics (AE 2110 or equivalent).

AE 3120 Fundamentals of Aerodynamics
This course introduces students to the aerodynamics of airfoils, wings, and aircraft in the subsonic and supersonic regimes. Topics covered include: prediction of aerodynamic forces (lift, drag) and moments, dynamic similarity, experimental techniques in aerodynamics, Kutta-Joukowski theorem, circulation, thin airfoil theory, panel methods, finite wing theory, subsonic compressible flow over airfoils, linearized

supersonic flow, and viscous flow over airfoils. Students may not receive credit for both AE 3120 and AE 3711.

Units: 1/3
Category:
Category I
Recommended Background:
incompressible and compressible fluid dynamics (AE 2110, AE 3110 or equivalent).

Propulsion and Energy

AE 4210 Fundamentals of Air-Breathing Propulsion
This course introduces the principles of operation of air-breathing engines, including gas-turbines (turbojets, turbofans, and turboprops), ramjets, and scramjets. Topics covered include: engine thrust and efficiency analysis; working principles and performance analysis of diffusers, compressors, combustors, and nozzles; parametric cycle analysis; effect of irreversibilities on performance. The topics covered are also relevant to the operation of gas-turbines used for power generation. Students may not receive credit for both AE 4210 and either AE 4710 or AE 4711.
Units: 1/3
Category:
Category I
Recommended Background:
thermodynamics (ES 3001, CH 3510, PH 2101 or equivalent), compressible fluid dynamics (AE 3110 or equivalent).

AE 4220 Fundamentals of Rocket Propulsion
This course provides a study of rocket propulsion systems for launch vehicles and spacecraft. Dynamics, performance, and optimization of rocket-propelled vehicles are presented. Performance and component analysis of chemical propulsion systems are covered including flight dynamics, vehicle staging, nozzle design, and thermochemistry of bipropellant and monopropellant thrusters. Different classes of electric thrusters are introduced along with the concept of optimal specific impulse. Students may not receive credit for both AE 4220 and AE 4719.

Units: 1/3
Category:
Category I
Recommended Background:
compressible fluid dynamics (AE 3110 or equivalent), thermodynamics (ES 3001, PH 2101, CH 3310 or equivalent).

Flight Dynamics & Control

AE 2310 Intro to Control of Aerospace Systems
This course introduces feedback control systems analysis and design for applications to aircraft and spacecraft. Topics include: linear dynamical systems modeling of aircraft and spacecraft motion, including linearization; identification and transient response analysis of typical modes of motion; time- and frequency domain analysis; Bode plots; criteria for stability; design of stability augmentation and, attitude and orbital control systems using linear state feedback or PID control; numerical simulation of controlled and uncontrolled aircraft and spacecraft motion. Students may not receive credit for both AE 2310 and either AE/ME 3703 or AE 3713.

Units: 1/3
Category:
Category I
Recommended Background:
ordinary differential equations (MA 2051 or equivalent), introductory dynamics (ES 2503, PH 2201 or equivalent), and linear algebra (MA 2071 or equivalent).

AE 2320 Intro to Orbital Mechanics
An introductory course that covers the fundamentals of space flight. Topics studied include: two-body orbital dynamics, classification of orbits, and time of flight analysis; geocentric orbits and impulsive maneuvers: orbit shaping, escape trajectories, Hohmann and non-Hohmann transfers; orbital elements in 3D; interplanetary Hohmann and generalized transfers, intercepts, flybys. Students may not receive credit for both AE 2320 and AE 2713.

Units: 1/3
Category:
Category I
Recommended Background:
multivariable calculus (MA 1024 or equivalent), differential equations (MA 2051 or equivalent), dynamics (ES 2503, PH 2201 or equivalent).

AE 3310 Fundamentals of Navigation and Communication
This course covers methods and current technologies in the analysis, synthesis, and practice of aerospace guidance, navigation, and communications systems. Topics covered include: attitude- and position kinematics, inertial navigation systems, global satellite navigation systems, communication architectures for satellite navigation, satellite link performance parameters and design considerations, tropospheric and ionospheric effects on radio-wave propagation, least squares estimation, and the Kalman filter. Students may not receive credit for both AE 3310 and AE 4733.

Units: 1/3
Category:
Category I
Recommended Background:
linear algebra (MA 2071 or equivalent), dynamics (ES 2503, PH 2201 or equivalent), and controls (AE 3713 or equivalent).

AE 4310 Fundamentals of Aircraft Dynamics and Control
This course covers models of fixed-wing aircraft dynamics, and the design of aircraft control systems. Topics include: aircraft performance, longitudinal and lateral flight dynamics, simulation methodologies, natural modes of motion, static and dynamic stability, and aircraft control systems (such as autopilot design, flight path control, and automatic landing). Students may not receive credit for both AE 4310 and AE 4723.

Units: 1/3
Category:
Category I
Recommended Background:
controls (AE 2320 or equivalent), attitude and position kinematics (AE 3310 or equivalent).

AE 4320 Fundamentals of Spacecraft Dynamics and Control

The course covers broad topics in spacecraft attitude dynamics, stability and control. The course includes a review of particle and two-body dynamics and introduction to rigid body dynamics. Orbital and attitude maneuvers are presented. Attitude control devices and momentum exchange techniques such as spinners, dual spinners, gravity gradient, and geomagnetic torques are presented. Attitude sensors/actuators are presented and the attitude control problem is introduced. Open-loop stability analysis for a variety of equilibrium conditions is discussed. Control using momentum exchange and mass expulsion (thrusters) devices is discussed. The analyses and designs will be implemented using scientific computing software such as MATLAB®. Students may not receive credit for both AE 4320 and AE 4713.

Units: 1/3
Category:
Category I
Recommended Background:
astronautics (AE 2310 or equivalent), dynamics (ES 2503, PH 2201 or equivalent), control (AE 2320 or equivalent).

Materials & Structures

AE 2410 Introduction to Aerospace Structures
This course provides a concise overview of statics and then focuses on basic stress analysis applied to simple aerospace structures. Topics in stress analysis include: concepts of stress and strain; basic constitutive relations; one-dimensional response to axial loading; thermal stresses; statically determinate and indeterminate problems; shear forces, bending moments, bending stresses and deflections in beams with symmetric cross sections; two-dimensional stress transformation and Mohr's circle; and an introduction to energy methods in structural analysis. Students may not receive credit for both AE 2410 and AE 2712.
Units: 1/3
Category:
Category I
Recommended Background:
differential, integral, multivariable calculus (MA 1021, MA 1022, MA 1024 or equivalent), mechanics (PH 1110, PH 1111, or equivalent).

AE 3420 Fundamentals of Aerospace Structures
This course focuses on intermediate-level topics in stress analysis relevant to aerospace structures. Topics include: buckling under centric and eccentric loadings with and without lateral loads applied; torsion of solid circular and noncircular cross sections; torsion of thin-walled multi-celled members; flexural shear flow in and shear center of thin walled multi-celled members; bending stresses in beams with unsymmetric cross sections; stresses under combined loadings; and three-dimensional states of stress. The laboratory component of this course provides testing and measurement experience related to buckling of columns under a variety of loadings and support conditions; and to the determination of the shear center and bending response of beams with unsymmetric cross sections. Students may not receive credit for both AE 3420 and AE 3712.

Units: 1/3
Category:
Category I
Recommended Background:
differential equations (MA 2051 or equivalent), introductory aerospace structures (AE 2410 or equivalent.)

AE 3430 Fundamentals of Composite Materials
This course provides an overview of the processing techniques and mechanical behavior of composite materials relevant to aerospace applications. Topics in this course may include: classification of composites; elasticity of composite materials; the effect of reinforcements on strength and toughness; bonding mechanisms of interfaces in composite; fabrication methods for polymer-matrix composite materials; viscoelasticity and creep of composites; advanced composites materials (bio-composites, nano-composites). Students may not receive credit for both AE 3430 and AE 4717.

Units: 1/3
Category:
Category I
Recommended Background:
introductory material science (ES 2001), and introductory stress analysis (AE 2410 or equivalent).

AE 4410 Fundamentals of Structural Dynamics
This course introduces the analysis of vibrations of flexible bodies encountered as elements of aircraft and space structures. Topics include: modeling of aerospace structures with lumped parameters using Newton's Law and Lagrange's equations, free- and forced- vibration response of single degree of freedom systems and multi-degree of freedom systems, design of simplified vibration absorption systems, dynamic testing, modal analysis for determining structural response of lumped and continuous systems. Students may not receive credit for both AE 4410 and AE 4712.

Units: 1/3
Category:
Category I
Recommended Background:
dynamics (ES 2503, PH 2201, PH2202 or equivalent), controls (AE 2320 or equivalent), aerospace structures (AE 3420 or equivalent).

Aerospace Design

AE 4510 Aircraft Design
This course introduces students to design of aircraft systems. Students complete a conceptual design of an aircraft in a term-long project. Students are exposed to the aircraft design process, and must establish design specifications, develop and analyze alternative designs, and optimize their designs to meet mission requirements. Students work together in teams to apply material learned in the areas of aerodynamics, aerospace materials, structures, propulsion, flight mechanics, and stability and control, to the preliminary design of an aircraft. The project requirements are selected to reflect real-life aircraft mission requirements, and teams are required to design systems which incorporate appropriate engineering standards and multiple realistic constraints. The teams present their design in a final report and oral presentation. Students may not receive credit for both AE 4010 and AE 4770.

Units: 1/3
Category:
Category I
Recommended Background:
aerodynamics (AE 3120 or equivalent), aerospace structures (AE 3420 or equivalent), air breathing propulsion (AE 4210 or equivalent), aircraft dynamics and control (AE 4310 or equivalent).

AE 4520 Spacecraft and Mission Design

This course introduces students to design of spacecraft and missions. Students are introduced to the process of designing a spacecraft and major subsystems to meet a specific set of objectives or needs. In addition, students will learn about different spacecraft subsystems and what factors drive their design. Students complete a term-long spacecraft design project conducted by teams. The project addresses orbital mechanics, the space environment, attitude determination and control, telecommunications, space structures, and propulsion, along with other spacecraft subsystems. The project requirements are selected to reflect real-life missions, and teams are required to design systems which incorporate appropriate engineering standards and multiple realistic constraints. The teams present their design in a final report and oral presentation. Students may not receive credit for both AE 4020 and AE 4771.

Units: 1/3
Category:
Category I
Recommended Background:
astronautics (AE 2310 or equivalent), space environments (AE/PH 2550), spacecraft dynamics and control (AE 4320 or equivalent), telecommunications (AE 3310), space structures (AE 3420 or equivalent), rocket propulsion (AE 4220 or equivalent).

Rational:
Current course names and numbers have been inherited from the years when Aerospace Engineering was a program within the Mechanical Engineering (ME) Department. The new name and numbers make it easy for a student to ascertain the area and level of the course. For example, "Introduction" is reserved for 2000-level courses, "Fundamentals of" is reserved for 3000- and 4000-level courses. The first digit of the new course numbers reflects the approximate level at which the course has been historically offered. The second digit of the new number designates one of the five curricular areas of courses within the Aerospace Engineering Department (AED): (1) Fluid Dynamics; (2) Propulsion and Energy; (3) Flight Dynamics and Controls; (4) Material and Structures; (5) Aerospace Design (0) General Engineering Topics. These curricular areas are consistent for both the undergraduate and graduate AE programs. The new numbers will help students move through the undergraduate program and into the graduate program in a seamless way. There are no revisions being made to the course descriptions from the current ones.

Implementation Date
Implementation date for this action is the 2022-2023 academic year.

Resource Needs
No additional resources are needed because there is no net increase in the number of courses taught by AE faculty.

Impact on Degree Requirements
No impact on distribution requirements.