

# AEROSPACE ENGINEERING (AE)

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## **AE 1355. Aerospace Systems Design Competition I. 3 Credit Hours.**

Team-oriented aerospace systems design project directed by a faculty advisor. Typically a national student competition in aircraft, rotorcraft, or spacecraft design. Technical role commensurate with freshman standing.

## **AE 1601. Introduction to Aerospace Engineering. 1 Credit Hour.**

Overview of aerospace engineering. Common terminology, introduction to use of engineering models, professional and ethical standards and experience with team-based design of aerospace systems. Students cannot receive credit for both AE 1601 and AE 1350.

## **AE 1750. Introduction to Bioengineering. 3 Credit Hours.**

An introduction to the field of bioengineering, including the application of engineering principles and methods to problems in biology and medicine, the integration of engineering with biology, and the emerging industrial opportunities. Crosslisted with BMED, CHE, ECE, ME, and MSE 1750.

## **AE 1XXX. Aerospace Engineering Elective. 1-21 Credit Hours.**

### **AE 2010. Thermodynamics & Fluids Fundamentals. 4 Credit Hours.**

Thermodynamic and fluid properties. Conservation laws, isentropic flow, shocks and expansions, introduction to flows with friction and heat transfer. Applications to aerospace devices. Students cannot receive credit for both AE 2010 and AE 3450.

### **AE 2010R. AE 2010 Recitation. 0 Credit Hours.**

This recitation is an optional session in support of AE 2010. This course is designed to allow students the chance to apply their knowledge of concepts through problem solving and group discussions.

### **AE 2011. Fluid Fundamentals. 2 Credit Hours.**

Flowfield concepts, fluid properties, conservation equations for flows, isentropic flow, shocks and expansions, introduction to flows with friction and heat transfer. Applications to aerospace devices.

### **AE 2011R. AR 2011 Recitation. 0 Credit Hours.**

This recitation is an optional session in support of AE 2011. This course is designed to allow students the chance to apply their knowledge of concepts through problem solving and group discussions.

### **AE 2220. Dynamics. 3 Credit Hours.**

Motion of particles and mass center of bodies, kinematics and kinetics of rigid bodies in plane motion, work-energy and impulse-momentum methods, 3-D dynamics of rigid bodies.

### **AE 2220R. AE 2220 Recitation. 0 Credit Hours.**

This recitation is an optional session in support of AE 2220. This course is designed to allow students the chance to apply their knowledge of concepts through problem solving and group discussions.

### **AE 2221. 3D Dynamics. 1 Credit Hour.**

Kinematics and kinetics of rigid bodies in three-dimensional motion.

### **AE 2221R. AE 2221 Recitation. 0 Credit Hours.**

This recitation is an optional session in support of AE 2221. This course is designed to allow students the chance to apply their knowledge of concepts through problem solving and group discussions.

## **AE 2355. Aerospace Systems Design Competition II. 3 Credit Hours.**

Team-oriented aerospace systems design project directed by a faculty advisor. Typically a national student competition in aircraft, rotorcraft, or spacecraft design. Technical role commensurate with sophomore standing.

## **AE 2610. Introduction to Experimental Methods in Aerospace. 1 Credit Hour.**

Introduction to laboratory instrumentation and measurement techniques used in aerospace. Basic application of sensor principles, uncertainty analysis, interpretation and analysis of experimental data, and documentation.

## **AE 2611. Technical Communications for Aerospace Engineers. 1 Credit Hour.**

Development of technical communication skills required by aerospace engineers. Includes written, oral and visual communication methods.

## **AE 2698. Undergraduate Research Assistantship. 1-12 Credit Hours.**

Independent research conducted under the guidance of a faculty member.

## **AE 2699. Undergraduate Research. 1-12 Credit Hours.**

Independent research conducted under the guidance of a faculty member.

## **AE 2801. Special Topics. 1 Credit Hour.**

Normally taken by sophomores. Course material devoted to special topics in aerospace engineering.

## **AE 2802. Special Topics. 2 Credit Hours.**

Normally taken by sophomores. Course material is devoted to special topics in aerospace engineering.

## **AE 2803. Special Topics. 3 Credit Hours.**

Normally taken by sophomores. Course material devoted to special topics in aerospace engineering.

## **AE 2901. Special Problems. 1-21 Credit Hours.**

Research topic selected in consultation with advisor. A brief description, endorsed by the faculty advisor, must be approved by the School.

## **AE 2902. Special Problems. 1-21 Credit Hours.**

Research topic selected in consultation with advisor. A brief description, endorsed by the faculty advisor, must be approved by the School.

## **AE 2903. Special Problems. 1-21 Credit Hours.**

Research topic selected in consultation with advisor. A brief description, endorsed by the faculty advisor, must be approved by the School.

## **AE 2XXX. Aerospace Engineering Elective. 1-21 Credit Hours.**

### **AE 3030. Aerodynamics. 4 Credit Hours.**

Aerodynamics of airfoils and wings in subsonic, transonic and supersonic flight. Laminar and turbulent boundary layers and effects of viscosity on aerodynamic performance.

### **AE 3030R. Aerodynamics Recitation. 0 Credit Hours.**

Recitation course for AE 3030.

## **AE 3090. Numerical Methods for Aerospace Engineering. 3 Credit Hours.**

Basic numerical methods in Aerospace Engineering taught in Fortran or C, language instruction included. Numerical integration, interpolation, FFT, linear algebra, initial and boundary value problems.

## **AE 3140. Structural Analysis. 3 Credit Hours.**

Application to structural analysis. Basic equations of elasticity. Bending, shearing and torsion of thin walled structures. Energy methods for structural analysis and application to finite element theory for trusses and beam structures. Students cannot receive credit for both AE 3140 and AE 3125.

## **AE 3330. Introduction to Aerospace Vehicle Performance. 3 Credit Hours.**

Orbital mechanics, orbit determination, and spacecraft maneuvers. Basics of airplane flight including climb, cruise, takeoff, and landing. Actuator disk theory and elements of rotorcraft performance.

**AE 3340. Design and Systems Engineering Methods. 2 Credit Hours.**

Overview of aerospace design and systems engineering. Tools to organize the design process and to support design decisions. Introduction to numerical optimization and trade studies.

**AE 3355. Aerospace Systems Design Competition III. 3 Credit Hours.**

Team-oriented aerospace systems design project directed by a faculty advisor. Typically a national student competition in aircraft, rotorcraft, or spacecraft design. Technical or leadership role commensurate with junior standing.

**AE 3450. Thermodynamics and Compressible Flow. 3 Credit Hours.**

First and second laws of thermodynamics. Thermodynamic properties and state equations. Isentropic flow. Flows with shocks and expansions. Flows with friction and heat transfer. Students cannot receive credit for both AE 3450 and AE 2010.

**AE 3530. System Dynamics and Vibration. 3 Credit Hours.**

Modeling and analysis of lumped- and distributed-parameter systems, free and forced vibration in mechanical systems, free vibration in structural systems. Students cannot receive credit for both AE 3530 and ME 3017 or AE 3530 and AE 3515.

**AE 3531. Control System Analysis and Design. 3 Credit Hours.**

Control system performance analysis and specifications, classical methods of control system analysis and design, introduction to modern control methods. Students cannot receive credit for AE 3531 and AE 3515 or AE 3531 and ME 4452.

**AE 3610. Experiments in Fluid and Solid Mechanics. 2 Credit Hours.**

Experimental laboratory in solid and fluid mechanics, aerodynamics, propulsion. Emphasis on measurement techniques, analysis and interpretation of data, comparison to analytical predictions, and reporting.

**AE 3801. Special Topics. 1 Credit Hour.**

Normally taken by juniors. Course material devoted to special topics in aerospace engineering.

**AE 3802. Special Topics. 2 Credit Hours.**

Normally taken by juniors. Course material devoted to special topics in aerospace engineering.

**AE 3803. Special Topics. 3 Credit Hours.**

Normally taken by juniors. Course material devoted to special topics in aerospace engineering.

**AE 3901. Special Problems. 1-21 Credit Hours.**

Research topic selected in consultation with advisor. A brief description, endorsed by the faculty advisor, must be approved by the School.

**AE 3902. Special Problems. 1-21 Credit Hours.**

Research topic selected in consultation with advisor. A brief description, endorsed by the faculty advisor, must be approved by the School.

**AE 3903. Special Problems. 1-21 Credit Hours.**

Research topic selected in consultation with advisor. A brief description, endorsed by the faculty advisor, must be approved by the School.

**AE 3XXX. Aerospace Engineering Elective. 1-21 Credit Hours.****AE 4040. Computational Fluid Dynamics. 3 Credit Hours.**

Discretization of PDEs, stability and accuracy considerations, iterative and time/space marching schemes, aerospace applications.

**AE 4060. Aeroacoustics. 3 Credit Hours.**

Concepts and techniques, noise sources, data acquisition and reduction, aeroacoustic resonances, commonalities in the music of wind instruments and sources of aircraft noise, community impact.

**AE 4070. Introduction to Propeller and Rotor Theory. 3 Credit Hours.**

A study of the theory and equations used in the design of propellers and helicopter rotors.

**AE 4071. Rotorcraft Aeromechanics. 3 Credit Hours.**

Basic rotor aerodynamics and dynamics, helicopter performance and trim, introduction to helicopter stability, control and vibration.

**AE 4080. Aerothermodynamics. 3 Credit Hours.**

Convective heat transfer and viscous drag in high-temperature and high-speed flowfields. Inviscid hypersonic theory, real gas effects, and wall thermal protection strategies.

**AE 4132. Finite Element Analysis. 3 Credit Hours.**

An introduction to classical approximation techniques and the fundamentals of the finite element-method applied to structures and structural dynamics with aerospace applications.

**AE 4170. Structural Integrity and Durability. 3 Credit Hours.**

Multiaxial stress states, inelasticity in metals and polymers, yield criteria, metal fatigue, fracture, stress intensity factors, fracture toughness, fatigue crack growth, metal creep, and polymer viscoelasticity.

**AE 4220. Structural Dynamics and Aeroelasticity. 3 Credit Hours.**

Structural dynamics of one-dimensional systems. Analysis of static aeroelastic phenomena, unsteady aerodynamics, and flutter. Equations of motion for complete aeroelastic systems; solution techniques.

**AE 4311. Aircraft Design I: Conceptual Design. 3 Credit Hours.**

Conceptual design and synthesis of fixed wing aircraft.

**AE 4312. Aircraft Design II: Preliminary Design. 3 Credit Hours.**

Preliminary design and synthesis of fixed wing aircraft.

**AE 4321. Space System Design I: Conceptual Design. 3 Credit Hours.**

Conceptual design and synthesis of space systems. Students apply mission and spacecraft design principles.

**AE 4322. Space System Design II: Mission Design. 3 Credit Hours.**

Advanced design applications of space systems. Students apply mission and spacecraft design principles.

**AE 4331. Rotorcraft Design I: Conceptual Design. 3 Credit Hours.**

Conceptual design of traditional, urban air mobility, unmanned rotorcraft vehicles.

**AE 4332. Rotorcraft Design II: Preliminary Design. 3 Credit Hours.**

Preliminary design of traditional, urban air mobility, unmanned rotorcraft vehicles.

**AE 4341. Aircraft Design. 3 Credit Hours.**

Aircraft Vehicle Design. Preliminary design or case study of a complete flight vehicle, including a propulsion system, a structural system, and a control system. Students cannot receive credit for both AE 4341 and AE 4350.

**AE 4342. Space System Design. 3 Credit Hours.**

Spacecraft subsystems and synthesis. Students apply mission and spacecraft design principles in developing a space flight mission concept. Topics may vary. Students cannot receive credit for AE 4342 and AE 4356.

**AE 4343. Rotorcraft Design. 3 Credit Hours.**

Rotorcraft Vehicle Design. Preliminary design or case study of a complete rotorcraft flight vehicle, including a propulsion system, a structural system, and a control system. Students cannot receive credit for both AE 4343 and AE 4358 or AE 4343 and AE 6333.

**AE 4355. Aerospace Systems Design Competition IV. 3 Credit Hours.**

Team-oriented aerospace systems design project directed by a faculty advisor. Typically a national student competition in aircraft, rotorcraft, or spacecraft design. Technical or leadership role commensurate with senior standing.

**AE 4361. Space Flight Operations. 3 Credit Hours.**

This course introduces the foundations and analysis of space flight operations for human and robotic space missions.

**AE 4370. Life Cycle Cost Analysis. 3 Credit Hours.**

Modeling of total cost of complex systems over their entire life cycle. Modeling risk uncertainty for complex energy, environmental, and military systems.

**AE 4376. Accident Causation and System Safety. 2 Credit Hours.**

This course provides an in-depth examination of the multi-disciplinary issues in accident causation and system safety (prevention) across different industries.

**AE 4451. Jet and Rocket Propulsion. 3 Credit Hours.**

Principles of aerospace propulsion systems. Thermodynamic cycles. Thermodynamics of combustion. Turbine engine and rocket performance characteristics. Cycle/component analysis of engines and turbomachinery.

**AE 4453. Advanced Aircraft Propulsion. 3 Credit Hours.**

Analysis, preliminary design of turbomachinery and combustors for aircraft; engine design, off-design performance. Introduction to advanced architectures: including scramjets, pressure gain combustion, electric propulsion.

**AE 4461. Introduction to Combustion. 3 Credit Hours.**

Basics of combustion and combustion devices. Chemical thermodynamics, reaction rates, premixed/nonpremixed flames, ignition, stabilization, and pollutants. Applications in turbine, rocket, and internal combustion engines.

**AE 4531. Aircraft Flight Dynamics. 3 Credit Hours.**

Three-dimensional rigid body dynamics, aircraft equations of motion, static and dynamic stability, flight control design, introduction to aeroelastic phenomena. Students cannot receive credit for both AE 4531 and AE 3521.

**AE 4532. Spacecraft Flight Dynamics. 3 Credit Hours.**

Cover fundamental material in orbit and attitude dynamics. Investigate orbits, rendezvous/intercept maneuvers, interplanetary transfers, attitude coordinates, attitude stability, attitude control, and attitude estimation. Students cannot receive credit for both AE 4532 and AE 4310.

**AE 4552. Introduction to Humans & Autonomy. 3 Credit Hours.**

Learn the fundamental principles underlying the functions performed by humans and by autonomous systems in dynamic, complex domains. Credit will not be awarded for both AE 4552 and AE 6552.

**AE 4580. Introduction to Avionics Integration. 3 Credit Hours.**

Avionics in modern aerospace vehicle systems, including impact on design and performance. Specific case-studies; covers: navigation, GPS, stability augmentation, radar, health monitoring, databases, human factors, and software.

**AE 4610. Dynamics and Control Laboratory. 2 Credit Hours.**

Experiments in dynamics and control related to aerospace engineering topics.

**AE 4698. Undergraduate Research Assistantship. 1-12 Credit Hours.**

Independent research conducted under the guidance of a faculty member.

**AE 4699. Undergraduate Research. 1-12 Credit Hours.**

Independent research conducted under the guidance of a faculty member.

**AE 4701. Wind Engineering. 3 Credit Hours.**

An introductory course on wind energy and its potential; modeling and design of wind turbines; analysis of the economic benefits of wind turbine systems. Credit not allowed for both AE 4701 and ME 4701.

**AE 4757. Biofluid Mechanics. 3 Credit Hours.**

Introduction to the study of blood flow in the cardiovascular system. Emphasis on modeling and the potential of flow studies for clinical research application. Crosslisted with CHE and ME 4757.

**AE 4758. Biosolid Mechanics. 3 Credit Hours.**

The mechanics of living tissue, e.g., arteries, skin, heart muscle, ligament, tendon, cartilage, and bone. Constitutive equations and some simple mechanical models. Mechanics of cells. Applications. Crosslisted with CHE and ME 4758.

**AE 4760. Engineering Acoustics and Noise Control. 3 Credit Hours.**

Study of acoustics related to noise and its control; acoustics terminology wave propagation, wave equation solutions, instrumentation, data processing, room acoustics, noise control, noise legislation. Crosslisted with ME 4760.

**AE 4791. Mechanical Behavior of Composites. 3 Credit Hours.**

Stress-strain behavior of composites, property of matrix and reinforcing materials, mechanics of fiber-reinforced composites, lamina and laminate analysis, and mechanical performance. Crosslisted with CEE, CHE, ME, MSE, and PTFE 4791.

**AE 4793. Composite Materials and Processes. 3 Credit Hours.**

Basic principles of selection and design of composite materials and their manufacturing and testing. Cost factors. Laboratory exercises on manufacturing and tests. Crosslisted with CEE, CHE, ME, MSE, and PTFE 4793.

**AE 4794. Composite Materials and Manufacturing Testing. 4 Credit Hours.**

Basic principles of selection and sign of composite materials and their manufacturing and testing. Cost factors. Laboratory exercises on manufacturing and tests. Crosslisted with CEE, CHE, ME, MSE, and PTFE 4794.

**AE 4801. Special Topics. 1 Credit Hour.**

Normally taken by seniors. Course material devoted to special topics in aerospace engineering.

**AE 4802. Special Topics. 2 Credit Hours.**

Normally taken by seniors. Course material devoted to special topics in aerospace engineering.

**AE 4803. Special Topics. 3 Credit Hours.**

Normally taken by seniors. Course material devoted to special topics in aerospace engineering.

**AE 4804. Special Topics. 4 Credit Hours.**

Normally taken by seniors. Course material devoted to special topics in aerospace engineering.

**AE 4806. Special Topics. 3 Credit Hours.**

Special Topics.

**AE 4863. Special Topics. 3 Credit Hours.**

Special Topics in Aerospace Engineering.

**AE 4864. Special Topics. 4 Credit Hours.**

Special Topics in Aerospace Engineering.

**AE 4883. Special Topics. 3 Credit Hours.**

**AE 4901. Special Problems in Aerospace Engineering. 1-21 Credit Hours.**

Research topic selected in consultation with advisor. A brief description, endorsed by the faculty advisor, must be approved by the School.

**AE 4902. Special Problems in Aerospace Engineering. 1-21 Credit Hours.**

Research topic selected in consultation with advisor. A brief description, endorsed by the faculty advisor, must be approved by the School.

**AE 4903. Special Problems. 1-21 Credit Hours.**

Research topic selected in consultation with advisor. A brief description, endorsed by the faculty advisor, must be approved by the School.

**AE 4XXX. Aerospace Engineering Elective. 1-21 Credit Hours.**