

# AEROSPACE ENGINEERING SCIENCES

Aerospace engineering sciences prepares students for successful and rewarding careers in aerospace and other high-tech industries, national research laboratories, government services and academia. This program provides students unique opportunities to develop in-depth technical knowledge, effective communication skills and a systems engineering perspective that enables them to develop creative solutions to complex problems. The curriculum encompasses core aerospace engineering subjects including fluid dynamics, thermodynamics, materials and structures, dynamical systems, orbital mechanics, air and space vehicle design with multidisciplinary applications including bioastronautics, unmanned systems, remote sensing and GPS.

The mission of the Ann and H.J. Smead Department of Aerospace Engineering Sciences (<https://www.colorado.edu/aerospace/>) is to provide students the highest quality education in aerospace engineering sciences, emphasizing hands-on learning, and to conduct fundamental, applied and interdisciplinary research to meet societal needs through analysis, design and implementation of aerospace systems, leveraging synergies between aerospace engineering and related sciences.

The department is uniquely characterized by:

- Blending aeronautics, astronautics and science applications.
- Providing an undergraduate experience characterized by rigorous preparation in mathematics and engineering sciences, a hands-on experiential approach to learning and an extensive emphasis on design in a systems context.
- Emphasizing our graduate education and research programs in the forefront of aerospace fundamentals, technology development, and integration of engineering and science activities to solve critical problems in the earth and space sciences.
- Creating graduates who are broadly educated, interdisciplinary, agile, team-oriented engineers and scientists, with end-to-end mission and systems perspectives.

Course code for this program is ASEN.

## Bachelor's Degree

- Aerospace Engineering Sciences - Bachelor of Science (BSAE) (<https://catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/aerospace-engineering-sciences/aerospace-engineering-science-bachelor-science-bsae/>)

## Faculty

While many faculty teach both undergraduate and graduate students, some instruct students at the undergraduate level only. For more information, contact the faculty member's home department.

Ahmed, Nisar R. ([https://experts.colorado.edu/display/fisid\\_153237/](https://experts.colorado.edu/display/fisid_153237/))  
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Professor, Director; PhD, University of Southampton (England)

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#### **ASEN 1000 (1) Introduction to Aerospace Engineering Sciences**

Introduces aerospace history, curriculum, ethics, and the many areas of emphasis within aerospace engineering. Academic and industry speakers are invited to address various aerospace topics.

**Requisites:** Restricted to students with 0-26 credits (Freshmen) Aerospace Engineering (ASEN) or Engineering Open Option majors only.

**Additional Information:** Departmental Category: Aerospace Design and System Engineering

#### **ASEN 1009 (1) Undergraduate Aerospace Seminar**

Introduce aerospace undergraduate students to world-class aerospace researchers and technical, policy, and/or current events topics.

**Repeatable:** Repeatable for up to 2.00 total credit hours.

**Requisites:** Restricted to Undergraduate Aerospace (ASEN-BSAE) or Undergraduate Engineering Open Option majors only.

#### **ASEN 1022 (3) Materials Science for Aerospace Engineers**

Covers prerequisite chemistry topics for materials science and introduces material types, properties and behavior for aerospace engineers.

Topics include review of chemistry; atomic bonding; crystals; diffusion; mechanical/thermal properties; phase diagrams; heat treatment; failure mechanisms; materials selection; and a general introduction to modern materials for aerospace engineering applications including composites and materials with engineered properties. Lab project or tensile testing is included.

**Requisites:** Requires pre/co-reqs APPM 1350 or MATH 1300 or APPM 1340 or APPM 1345 ASEN 1320 or CHEN 1310 or CSCI 1300 or CSCI 1310 or CSCI 1320 or ECEN 1310 (all min grade C-). Restricted to ASEN mjs, IDEN-BSIDE mjrs w/ Aero emphasis, IUT On Track students.

**Additional Information:** Departmental Category: Structures, Materials, and Structural Dynamics

#### **ASEN 1320 (4) Aerospace Computing and Engineering Applications**

Uses problems and tools from Engineering. Teaches techniques for writing computer programs in higher level programming languages to solve problems of interest in Engineering and other domains. Appropriate for students with little or no prior experience in programming.

**Requisites:** Requires a prerequisite or corequisite course of APPM 1235 or APPM 1340 or APPM 1345 or APPM 1350 or MATH 1150 or MATH 1300 or MATH 1310 (all minimum grade C-). Restricted to College of Engineering majors IUT On Track applicants.

#### **ASEN 1400 (3) Gateway to Space**

Introduces the basics of atmosphere and space sciences, space exploration, spacecraft design, rocketry and orbits. Students design, build, and launch a miniature satellite on a high altitude balloon. Explores the current research in space through lectures from industry.

**Equivalent - Duplicate Degree Credit Not Granted:** ASTR 2500, GEEN 1400, ASEN 1403 and ECEN 1400

**Requisites:** Restricted to College of Engineering students with a maximum of 50 credit hours.

**Additional Information:** Departmental Category: Aerospace Design and System Engineering

#### **ASEN 1403 (3) Introduction to Rocket Engineering**

Introduces students to the engineering profession through completion of a team-based project. Students design, build, and static test-fire a liquid-solid hybrid rocket motor. Topics explored include: pressure vessels, combustion, ideal fluid behavior, systems engineering, data acquisition, and model verification. Learned skills will include technical writing, teamwork, computer modelling and analysis tools, 3D printing and prototyping technologies.

**Equivalent - Duplicate Degree Credit Not Granted:** ASTR 2500, GEEN 1400, ASEN 1400 and ECEN 1400

**Requisites:** Restricted to College of Engineering students with 50 credits or fewer completed.

**ASEN 1969 (3) Pathway to Space**

Explore the many paths one can take to be a part of a space-related career in a unique, engaging and interactive course. Students will learn about the following topics: space science and exploration, human spaceflight and life sciences, aeronautics and near space, launch and spacecraft systems, climate and environment, space business, policy and politics, space arts, media, and history.

**Additional Information:** Departmental Category: Specialized Courses

**ASEN 2012 (2) Experimental and Computational Methods in Aerospace Engineering Sciences**

Introduces statistical, experimental, and computational methods used in aerospace engineering sciences. Usage of MatLab is extensive.

**Requisites:** Requires prereqs ASEN 1320 or CSCI 1300 or CHEN 1310 or ECEN 1310 PHYS 1110 (all min grade C-). Requires pre/co-req APPM 2360 or MATH 2130 MATH 3430 (min grade C-). Restricted to ASEN mjrs, IDEN-BSIDE mjrs w Aero emphasis, IUT On Track students.

**Additional Information:** Departmental Category: Aerospace Design and System Engineering

**ASEN 2401 (3) Statics**

Introduces applied vector mechanics with an emphasis on static equilibrium. Focuses on vectors, free body diagrams, and static equilibrium in 2D and 3D. Covers analysis of trusses, frames, and machines. Examines internal forces in structures and the development of shear and bending moment diagrams.

**Requisites:** Requires prerequisite courses APPM 1360 or MATH 2300 and PHYS 1110 (all minimum grade C-).

**ASEN 2402 (3) Thermodynamics**

Introduces the fundamental concepts and principles of thermodynamics with an emphasis on understanding how these basic physical principles can be used to solve numerical problems. Covers the properties of pure substances, control volume analysis, first law of thermodynamics, ideal gas law, second law of thermodynamics, and thermodynamic cycles. Synthesizes as a primary goal basic science (physics) and mathematics for the analysis and design of thermodynamic systems.

**Requisites:** Requires prerequisite courses APPM 1360 or MATH 2300 and PHYS 1110 (all minimum grade C-).

**Recommended:** Corequisites MCEN 1024 or CHEN 1201 or CHEN 1211 or CHEM 1113 or CHEM 1400.

**ASEN 2403 (3) Dynamics**

Provides students with essential concepts in dynamics, serving as a prerequisite for advanced courses that build upon these foundational principles, including those focused on the dynamics and control of air and space vehicles.

**Requisites:** Requires prerequisite courses ASEN 1320 or CSCI 1300 or CHEN 1310 or ECEN 1310 and ASEN 2401 or MCEN 2023 or CVEN 2121 or GEEN 2851 (all minimum grade C-). Requires corequisites of APPM 2360 or MATH 2130 MATH 3430.

**ASEN 2501 (3) Introduction to Astronautics**

Introduces spacecraft mission topics such as orbital mechanics, spacecraft design, rocket propulsion, communications, remote sensing, and the space environment. Utilizes active and problem-based learning techniques to expose students to the space industry.

**Requisites:** Requires prerequisite courses of ASEN 1320 or CSCI 1300 or CHEN 1310 or ECEN 1310 and APPM 1360 or MATH 2300 and PHYS 1110 (all minimum grade C-).

**ASEN 2502 (3) Introduction to Aeronautics**

Introduces theory and methods for the design and performance analysis of aeronautical vehicles with a focus on fixed wing aircraft. Emphasizes systems engineering aspects, touching upon relevant subdisciplines including: the standard atmosphere and air transport environment, aerodynamics, propulsion, stability and control, and structural dynamics. Incorporates hands-on laboratory and design components throughout the semester.

**Requisites:** Requires prerequisite courses of ASEN 1320 or CSCI 1300 or CHEN 1310 or ECEN 1310 and APPM 1360 or MATH 2300 and PHYS 1110 (all minimum grade C-).

**ASEN 2519 (1-3) Special Topics**

Studies specialized aspects of the aerospace engineering sciences or innovative treatment of required subject matter at the lower-division level. Course content is indicated in the online Schedule Planner. Department enforced prerequisites: varies.

**Repeatable:** Repeatable for up to 10.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to College of Engineering (ENGRU) undergraduates only.

**Additional Information:** Departmental Category: Specialized Courses

**ASEN 2701 (3) Introduction to Statics, Structures, and Materials**

Introduces the fundamental analytical tools for statics and structural analysis in the context of the physics of aerospace materials. Topics include force/moment equilibrium, truss analysis, beam theory, stress and strain, stiffness and strength of material, and aerospace structural design.

**Requisites:** Requires prereqs APPM 1360 or MATH 2300 PHYS 1110 (all min grade C-). Requires pre/co-req of APPM 2360 or MATH 2130 MATH 3430 (all min grade C-). Restricted to Aero(ASEN) mjrs, Integ Dsgn Engr(IDEN-BSIDE) mjrs w Aero emphasis, IUT OnTrack students

**ASEN 2702 (3) Introduction to Thermodynamics and Aerodynamics**

Introduces the fundamental principles and concepts of thermodynamics and aerodynamics. Topics include the first law of thermodynamics, properties of pure substances, control volume analysis, one-dimensional incompressible and compressible flows, two-dimensional lift and drag, and introduction to viscous flows.

**Requisites:** Requires prereqs APPM 1360 or MATH 2300 PHYS 1110 (all min grade C-). Requires pre/co-req of APPM 2360 or MATH 2130 MATH 3430 (all min grade C-). Restricted to Aero(ASEN) mjrs, Integ Dsgn Engr(IDEN-BSIDE) mjrs w Aero emphasis, IUT OnTrack students

**ASEN 2703 (3) Introduction to Dynamics and Systems**

Introduces the principles of particle and planar rigid body dynamics, systems, and controls. Topics include kinematics, kinetics, momentum and energy methods, system modeling, and simple feedback control.

**Requisites:** Requires prerequisite courses ASEN 2701 and APPM 2360 or MATH 2130 MATH 3430 (all min grade C-). Requires prerequisite or corequisite course of APPM 2350 or MATH 2400 (min grade C-). Restricted to ASEN majors and IDEN majors with an Aerospace emphasis

**ASEN 2704 (3) Introduction to Aerospace Vehicle Design and Performance**

Introduction to the theory and methods for design and performance analysis of aircraft and spacecraft. Aircraft topics include wing design, propulsion, aircraft performance, and stability and control. Spacecraft topics include mission design, rocket performance, orbital mechanics and spacecraft subsystems. Emphasis is placed on introducing systems engineering aspects of design and analysis for aerospace vehicles.

**Requisites:** Requires prerequisite courses ASEN 2702 and APPM 2360 or MATH 2130 MATH 3430 (all min grade C-). Requires prerequisite or corequisite course of APPM 2350 or MATH 2400 (min grade C-). Restricted to ASEN majors and IDEN majors with an Aerospace emphasis

**ASEN 2802 (1) Aerospace Sciences Lab I**

Provides an introductory laboratory experience in aerospace sciences, with a focus on statics, structural mechanics, thermodynamics, and aerodynamics. Emphasizes model-based design, experimental data collection, and interpretation of experimental data.

**Requisites:** Requires prereq ASEN 1320 or CHEN 1310 or CSCI 1300 or 1310 or 1320 or ECEN 1310 (min grade C-). Requires pre/co-reqs ASEN 2012 ASEN 2701 ASEN 2702 (min grade C-). Restricted to ASEN mjrs, IDEN-BSIDE mjrs w Aero emphasis, IUT On Track students.

**ASEN 2803 (1) Dynamics and Controls Lab**

Experimental and design laboratory exercises for aerospace applications of dynamics, systems, and controls principles.

**Requisites:** Requires prereqs ASEN 1320 or CHEN 1310 or CSCI 1300 or 1310 or 1320 or ECEN 1310 (min. grade C-). Requires pre/co-req ASEN 2012 and ASEN 2703. Restricted to Aerospace (ASEN) majors and IDEN majors with Aero emphasis.

**ASEN 2804 (2) Aerospace Vehicle Design Lab**

Design lab focused on integrating knowledge of 2000-level aerospace course concepts towards the open-ended exploration of conceptual and preliminary designs of an aerospace vehicle.

**Requisites:** Requires prerequisites ASEN 1320 or CHEN 1310 or CSCI 1300 or 1310 or 1320 or ECEN 1310(min. grade C-).Requires prerequisite or corequisite ASEN 2012 ASEN 2704(min. grade C-).Restricted to Aerospace Eng (ASEN) majors IDEN majors w/ Aerospace emphasis

**ASEN 2849 (1-3) Independent Study**

Study of special projects agreed upon by student and instructor. Department consent required.

**Repeatable:** Repeatable for up to 9.00 total credit hours. Allows multiple enrollment in term.

**Additional Information:** Departmental Category: Specialized Courses

**ASEN 3036 (3) Introduction to Human Spaceflight**

Introduces students to the challenges of human space flight. Historical and current space programs and spacecraft are discussed with emphasis on those systems specific to sustaining human crews. Other topics include space environment with respect to sustaining human life and health, physiological and psychological concerns in a space habitat, astronaut selection and training, anomalies, mission operations motivation, costs rationale for human space exploration, and future program directions. Not accepted as a Professional Area Elective for ASEN majors.

**Additional Information:** Departmental Category: Bioastronautics and Microgravity Science

**ASEN 3046 (3) Introduction to Humans in Aviation**

Investigates the history of crewed aviation accomplished through a review of the history of flight, the physiological and psychological limitations facing aviators, and investigates the human related causal factors in aviation accidents. The course also looks at the social and economic impacts of aviation in modern society. Not accepted as a Professional Area Elective for ASEN majors.

**Additional Information:** Departmental Category: Bioastronautics and Microgravity Science

**ASEN 3300 (4) Aerospace Electronics and Communications**

Provides the fundamentals of electronics and communications widely used in aerospace engineering. Includes analog instrumentation electronics, data acquisition, digital electronics and radio communication.

**Requisites:** Requires prerequisite courses ASEN 2703 and PHYS 1120 and APPM 2350 or MATH 2400 and APPM 2360 or MATH 2130 MATH 3430 (all minimum grade C-). Restricted to Aerospace Engineering (ASEN) majors and Integrated Design Eng majors with an Aerospace emphasis

**Additional Information:** Departmental Category: Systems and Control

**ASEN 3401 (3) Aerospace Structures**

Introduces concepts of stress and strain; axial loading, torsion, simple bending, transverse shear, and deflections of beams; analysis of stress and strain in 2-D and 3-D; failure analysis of structural components; and criteria for designing structural elements to meet requirements for aerospace structures.

**Requisites:** Requires prerequisite course of ASEN 2401 or MCEN 2023 or CVEN 2121 or GEEN 2851 (minimum grade C-).

**Recommended:** Prerequisites APPM 2350 or MATH 2400 and APPM 2360 or MATH 2130 & MATH 3430.

**ASEN 3402 (3) Aerospace Heat Transfer**

Introduces the fundamental concepts and principles of heat transfer in aerospace contexts. Covers the mechanisms of heat transfer by conduction, convection, and radiation. Emphasizes problem formulation and selection of appropriate solution techniques, with applications to modern aerospace engineering systems.

**Requisites:** Requires prerequisite courses of ASEN 2402 or MCEN 3012 or GEEN 3852 or AREN 2110 or EVEN 3012 and APPM 2360 or MATH 2130 MATH 3430 (all minimum grade C-). Requires corequisite course of APPM 2350 or MATH 2400.

**ASEN 3403 (3) Aerodynamics**

Introduces models for the analysis of subsonic, transonic, and supersonic flow. Teaches methodologies for the prediction of aerodynamics forces and moments experienced by aerospace vehicles and systems. Develops a fundamental understanding of gas dynamics in nozzles with application to wind tunnels and rocket propulsion.

**Requisites:** Requires prerequisite courses of ASEN 2402 or MCEN 3012 or GEEN 3852 or AREN 2110 or EVEN 3012 and APPM 2350 or MATH 2400 and APPM 2360 or MATH 2130 MATH 3430 (all minimum grade C-).

**ASEN 3404 (3) Aerospace Dynamics and Control**

Provides an overview of fundamental topics for aerospace vehicle dynamics and control. Introduces 3D rigid body dynamics, attitude representations, environmental forces and moments, linearization, modal responses and stability, control analysis and design, and attitude determination with examples from aircraft and spacecraft throughout.

**Requisites:** Requires prerequisite courses of ASEN 2403 or MCEN 2043 or CVEN 3111 and APPM 2350 or MATH 2400 and APPM 2360 or MATH 2130 MATH 3430 (all minimum grade C-).

**ASEN 3405 (3) Astrodynamics**

Provides a foundational knowledge of astrodynamics with a focus on spacecraft traveling near a single central body.

**Requisites:** Requires prerequisite course of ASEN 2501 (minimum grade C-). Requires corequisite course of ASEN 3404.

**ASEN 3406 (3) Aircraft Dynamics**

Provides a framework and methods for analyzing aircraft dynamics and designing aircraft control systems building on fundamental dynamics and control theory.

**Requisites:** Requires prerequisite courses of ASEN 2502 and ASEN 3403 (all minimum grade C-).

**ASEN 3501 (3) Aerospace Experimental Methods**

Introduces the essential aspects of hands-on experimentation for aerospace engineering applications, allowing students to learn the practical skills required for designing and conducting experiments in addition to analyzing results and quantifying confidence and uncertainty. Explores the importance of systematically analyzing experimental data, emphasizing the application of basic statistical methods and validation of fundamental engineering models.

**Requisites:** Requires prerequisite courses of ASEN 2402 or MCEN 3012 or GEEN 3852 or AREN 2110 or EVEN 3012 and ASEN 2403 or MCEN 2043 or CVEN 3111 and APPM 2350 or MATH 2400 and APPM 2360 or MATH 2130 MATH 3430 (all minimum grade C-).

**Recommended:** Prerequisites ASEN 2501 and ASEN 2502.

**ASEN 3502 (3) Aerospace Computational Methods**

Introduces computational methods commonly employed in the aerospace industry, emphasizing computational cost, accuracy, and error control. Covers numerical solution of systems of algebraic and differential equations, numerical optimization, and regression. Explores application to modeling, simulation, design, and control of aerospace systems.

**Requisites:** Requires prerequisite courses of ASEN 2402 or MCEN 3012 or GEEN 3852 or AREN 2110 or EVEN 3012 and ASEN 2403 or MCEN 2043 or CVEN 3111 and APPM 2350 or MATH 2400 and APPM 2360 or MATH 2130 MATH 3430 (all minimum grade C-).

**Recommended:** Prerequisites ASEN 2501 and ASEN 2502.

**ASEN 3503 (3) Aerospace Electronics**

Provides an overview of the fundamentals of analog and digital electronics widely used in aerospace engineering. Covers DC and AC circuits, frequency domain analysis, operational amplifiers, digital logic circuits, and computer interfaces.

**Requisites:** Requires prerequisite courses of ASEN 2403 or MCEN 2043 or CVEN 3111 and APPM 2360 or MATH 2130 MATH 3430 and PHYS 1120 (all minimum grade C-).

**ASEN 3519 (1-3) Special Topics**

Studies specialized aspects of the aerospace engineering sciences or innovative treatment of required subject matter at the upper-division level. Course content is indicated in the online Schedule Planner. Department enforced prerequisite: varies.

**Repeatable:** Repeatable for up to 9.00 total credit hours.

**Requisites:** Restricted to College of Engineering (ENGRU) undergraduates only.

**Additional Information:** Departmental Category: Specialized Courses

**ASEN 3700 (3) Orbital Mechanics/Attitude Dynamics and Control**

Presents the fundamentals of orbital mechanics, 3D rigid body dynamics and satellite attitude dynamics and controls.

**Requisites:** Requires prerequisite courses of ASEN 2703 and ASEN 2704 and APPM 2350 or MATH 2400 (all minimum grade C-). Restricted to Aerospace Engineering (ASEN) majors and IDEN majors with an Aerospace emphasis.

**ASEN 3711 (3) Aerodynamics**

Introduces models for the analysis of subsonic, transonic, and supersonic flow. Teaches methodologies for the prediction of aerodynamics forces and moments experienced by aircraft. Develops a fundamental understanding of gas dynamics in nozzles with application to aircraft and rocket propulsion.

**Requisites:** Requires prerequisite courses of ASEN 2704 and APPM 2350 or MATH 2400 (all minimum grade C-). Restricted to Aerospace Engineering (ASEN) majors and IDEN majors with an Aerospace emphasis.

**ASEN 3712 (3) Structures**

Teaches Mechanics of Materials methods of stress and deformation analysis applicable to the design and verification of aircraft and space structures. It offers an introduction to matrix and finite element methods for truss structures, and to mechanical vibrations.

**Requisites:** Requires prerequisite courses of ASEN 2703 and APPM 2350 or MATH 2400 (all minimum grade C-). Restricted to Aerospace Engineering (ASEN) majors and IDEN majors with an Aerospace emphasis.

**ASEN 3713 (3) Thermodynamics and Heat Transfer**

Focuses on the applications of the first and second laws of thermodynamics and teaches the fundamental concepts of different modes of energy and heat transfer, with applications of these concepts in gas dynamics, high-speed vehicle and spacecraft design, environmental systems, and energy analysis.

**Requisites:** Requires prerequisite courses ASEN 2702 and APPM 2350 or MATH 2400 and APPM 2360 or MATH 2130 MATH 3430 (all minimum grade C-). Restricted to ASEN majors and IDEN majors with an Aerospace emphasis.

**ASEN 3728 (3) Aircraft Dynamics**

Develops the fundamental concepts of aircraft dynamics. Covers flight mechanics, performance, dynamics and control of aircraft and how they impact aircraft design.

**Requisites:** Requires prerequisite courses of ASEN 2703 and ASEN 2704 and APPM 2350 or MATH 2400 (all minimum grade C-). Restricted to Aerospace Engineering (ASEN) majors and IDEN majors with an Aerospace emphasis.

**ASEN 3801 (1) Aerospace Vehicles Dynamics and Controls Lab**

Emphasizes applications of engineering dynamics and control principles for modeling, simulating, designing, analyzing, and evaluating aerospace vehicle systems. Experimental and computational focus on problems in aircraft flight stabilization and spacecraft attitude control.

**Requisites:** Requires prerequisite courses ASEN 2803 and ASEN 2804 (all minimum grade C-). Requires prerequisite or corequisite ASEN 3700 and ASEN 3728 (all minimum grade C-). Restricted to Aerospace Engineering (ASEN) majors and IDEN majors with an Aerospace emphasis

**ASEN 3802 (1) Aerospace Sciences Lab II**

Provides an intermediate laboratory experience in aerospace sciences, with a focus on aerodynamics, structural mechanics, thermodynamics, and heat transfer. Emphasizes design and analysis of experiments, processing and analysis of experimental data, and model validation using experimental data.

**Requisites:** Requires prerequisite courses ASEN 2012 and ASEN 2802 (min grade C-). Requires prerequisite or corequisite courses ASEN 3711, ASEN 3712 and ASEN 3713 (min grade C-). Restricted to Aerospace Engineering (ASEN) majors and IDEN majors w/ Aerospace emphasis

**ASEN 3930 (6) Aerospace Engineering Cooperative Education**

Students will participate in a previously arranged, department-sponsored cooperative education program with a government agency or industry. 0.

**Requisites:** Restricted to students with 57-180 credits (Junior or Senior) Aerospace Engineering (ASEN) majors only.

**Recommended:** Prerequisite GPA above 3.

**Additional Information:** Departmental Category: Specialized Courses

**ASEN 4013 (3) Foundations of Propulsion**

Describes aerothermodynamics and design of both rocket and air-breathing engines. Includes ramjets, turbojets, turbofans, and turboprop engines, as well as liquid, solid, and hybrid rockets.

**Requisites:** Requires prerequisite courses of ASEN 3711 and ASEN 3713 (all minimum grade C-). Restricted to Aerospace Engineering (ASEN), Aerospace Engineering Concurrent Degree (C-ASEN) or IDEN-BSIDE majors with Aerospace emphasis.

**Additional Information:** Departmental Category: Thermodynamics and Propulsion

**ASEN 4018 (4) Senior Projects 1: Design Synthesis**

Focuses on the synthesis of technical knowledge, project management, design process, leadership, and communications within a team environment. Students progress through the design process beginning with requirements development, then preliminary design and culminating with critical design. Offered fall only.

**Requisites:** Restricted to ASEN mjrs w/ prereqs ASEN 1022, 3711, 3712, 3713, 3728, 3700, 3300, 3801 and 3802 (all min grade C-). OR restricted to IDEN majors with an Aero emphasis w/ prereqs GEEN 2400, 3400, ASEN 1022, 3713, and 3300 (all min grade C-).

**Additional Information:** Departmental Category: Aerospace Design and System Engineering

**ASEN 4028 (4) Senior Projects 2: Design Practicum**

Focuses on the fabrication, integration, verification and validation of designs produced in ASEN 4018. Students work within the same teams from ASEN 4018. Offered spring only.

**Requisites:** Requires prerequisite course of ASEN 4018 (minimum grade C-). Restricted to Aerospace Engineering (ASEN) majors and Integrated Design Engineering majors with an Aerospace emphasis.

**Additional Information:** Departmental Category: Aerospace Design and System Engineering

**ASEN 4057 (3) Aerospace Software**

Provides an overview of prevalent software and hardware computing concepts utilized in practice and industry. Establishes the background necessary to tackle programming projects on different computing platforms with various software tools and programming languages.

**Requisites:** Requires prerequisite course of ASEN 1320 or CSCI 1300 or ECEN 1310 or CHEN 1310 (minimum grade C-). Restricted to Aerospace Engineering (ASEN) or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.

**Recommended:** Prerequisite CSCI 2270 or instructor consent.

**Additional Information:** Departmental Category: Computational and Analytic Methods

**ASEN 4067 (3) Microavionics: Introduction to PIC Microcontrollers for Aerospace Systems**

Provide students an introduction into embedded systems that teaches a basic understanding about the fundamental architecture of a microcontroller and how it operates and interfaces with both sensors and actuators applicable to aerospace engineering. Students will learn how to interface sensors to a PIC microcontroller, collect input, make decisions and take an action in real-time. To gain a full appreciation about how microcontrollers work, students develop their own software code using MPLAB X to program the development board hardware, which uses the Microchip PIC18F87K22 microcontroller as the foundation of the course. Students learn-by-doing through lab assignments and a semester final project. This includes programming in assembly language and then C, to collect data from external sources such as a serial terminal, temperature and rotary sensors, etc. and outputting results to a liquid crystal display (LCD), and sending commands to an actuator such as a servo.

**Equivalent - Duplicate Degree Credit Not Granted:** ASEN 5067

**Requisites:** Requires prerequisite courses of (ASEN 1320 or CSCI 1300 or CSCI 1310 or CHEN 1310 or ECEN 1310) and ASEN 3300 (all minimum grade C).

**ASEN 4090 (3) Global Positioning Systems Applications**

Focuses on GPS technology, software development, and applications. Lectures will cover the principal concepts used in GPS, and weekly laboratories will apply that knowledge. Culminates in student design projects using GPS.

**Requisites:** Requires prerequisite courses of APPM 2360 and CHEN 1310 (all minimum grade C).

**Recommended:** Prerequisite junior/senior standing in engineering.

**Additional Information:** Departmental Category: Global Positioning Systems

**ASEN 4114 (3) Automatic Control Systems**

Methods of analysis and design of feedback control for dynamic systems. Covers nyquist, bode and linear quadratic methods based on frequency domain and state space models. Laboratory experiments provide exposure to computation for simulation and real time control, and typical control system sensors and actuators.

**Equivalent - Duplicate Degree Credit Not Granted:** ASEN 5114

**Requisites:** Requires prerequisite courses of ASEN 3128 and ASEN 3200 (all minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.

**Additional Information:** Departmental Category: Systems and Control

**ASEN 4123 (3) Vibration Analysis**

Highlights free and forced vibration of discrete and continuous systems. Examines Lagrange's equation, Fourier series, Laplace transforms, and matrix and computational methods. Applies knowledge to practical engineering problems.

**Equivalent - Duplicate Degree Credit Not Granted:** MCEN 4123

**Requisites:** Requires prerequisite course of ASEN 3112 or MCEN 3030 (minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.

**Additional Information:** Departmental Category: Thermodynamics and Propulsion

**ASEN 4128 (3) Human Factors in Engineering and Design**

Introduces the field of human factors engineering and investigates human psychological, physiological and performance limitations in complex systems and why it is vital for engineers to understand human operational limitations when designing complex systems. Course includes studies of real accidents caused by human error, good and bad designs, latent conditions and accident-producing designs. Goal is an understanding of how to conduct engineering design with consideration of human factors.

**Requisites:** Restricted to students with 57-180 credits (Juniors or Seniors).

**Additional Information:** Departmental Category: Aerospace Design and System Engineering

**ASEN 4138 (3) Aircraft Design**

Two lectures and one lab per week. Examines principles of aircraft configuration and design to meet given performance specifications, taking into account aerodynamic, stability and control, and flying quality considerations, as well as airworthiness regulations. Includes preliminary design of the major elements of an aircraft.

**Requisites:** Requires prerequisite course of ASEN 3128 or ASEN 3728 (minimum grade C). Restricted to Aerospace Engineering (ASEN) or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.

**Additional Information:** Departmental Category: Aerospace Design and System Engineering

**ASEN 4218 (3) Large Space Structures Design**

Develops the necessary structural analysis skills for conducting conceptual and preliminary designs of large space structures with a practical emphasis on structures considered by NASA over the past 20 years. Applies analysis skills to a broad range of space missions requiring large space structures, emphasizing low cost and practical design.

**Equivalent - Duplicate Degree Credit Not Granted:** ASEN 5218

**Requisites:** Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Aerospace Engineering (ASEN) or Mechanical Engineering (MCEN) majors only.

**Additional Information:** Departmental Category: Aerospace Design and System Engineering

**ASEN 4338 (3) Computer Analysis of Structures**

Covers basic structural design concepts and finite element modeling techniques. Emphasizes use of finite element static and dynamic analysis to validate and refine an initial design. Introduces basic design optimization and tailoring. Proficiency in Matlab required.

**Requisites:** Requires prerequisite course of ASEN 3112 (minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only

**Additional Information:** Departmental Category: Structures, Materials, and Structural Dynamics

**ASEN 4401 (3) Aerospace Communication Systems**

Provides students with an understanding of basic wireless communication concepts relevant to aerospace systems and the near-earth atmosphere as well as an understanding of space-environment conditions that impact wireless aerospace communication systems.

**Requisites:** Requires prerequisite courses of ASEN 2501 and ASEN 3503 (all minimum grade C-)

**ASEN 4519 (1-3) Special Topics**

Studies specialized aspects of the aerospace engineering sciences or innovative treatment of required subject matter at the upper-division level. Course content is indicated in the online Schedule Planner.

Department enforced prerequisite varies.

**Repeatable:** Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to College of Engineering (ENGRU) undergraduates only.

**Additional Information:** Departmental Category: Specialized Courses

**ASEN 4849 (1-3) Independent Study**

Special projects agreed upon by student and instructor. Department consent required.

**Repeatable:** Repeatable for up to 6.00 total credit hours.

**Additional Information:** Departmental Category: Specialized Courses

**ASEN 4859 (1-6) Undergraduate Research**

Assigns a research problem on an individual basis. Department consent required.

**Repeatable:** Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

**Additional Information:** Departmental Category: Specialized Courses