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 subjects including fluids, thermodynamics, dynamics, orbital mechanics, structures and systems, design of air and space vehicles and exciting 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 in our graduate education and research programs forefront aerospace technology development and the integration of engineering and science activities to solve critical problems in the earth and space sciences, and
• creating graduates who are broadly educated, interdisciplinary, agile, team-oriented engineers and scientists, with end-to-end mission and systems perspectives.

Program Educational Objectives

During their first few years after the completion of their degrees, graduates of the Ann and H.J. Smead Aerospace Engineering Sciences Department will have:

• established themselves in professional careers or received a graduate degree,
• demonstrated ethical leadership, project management and/or innovation, and
• played significant roles in the research and development of engineering systems and products.

Student Outcomes

Students completing the undergraduate degree in Aerospace Engineering Sciences will be knowledgeable in the following areas:

• the professional context of the practice of aerospace engineering and expectations of new graduates in aerospace engineering organizations, including an awareness of ethics issues, economics, and the business environment,
• the history of aerospace engineering, providing a perspective on current events,
• aerospace engineering as a highly multidisciplinary endeavor, requiring a systems perspective to integrate technologies and manage complexity, and
• major principles and scientific methods underlying the technologies comprising aerospace vehicles and systems.

Upon graduation, students will have developed the following general skills and abilities:

• an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
• an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
• an ability to communicate effectively with a range of audiences
• an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
• an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
• an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions
• an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Course code for this program is ASEN.

Bachelor’s Degree

• Aerospace Engineering Sciences - Bachelor of Science (BSAE) (catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/aerospace-engineering-sciences/aerospace-engineering-science-bachelor-science-bs)

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 Razzi (https://experts.colorado.edu/display/fisid_153237) Assistant Professor; PhD, Cornell University

Akos, Dennis M. (https://experts.colorado.edu/display/fisid_131119) Professor; PhD, Ohio University

Anderson, Allison P. (https://experts.colorado.edu/display/fisid_156275) Assistant Professor; PhD, Massachusetts Institute of Technology

Argrow, Brian M (https://experts.colorado.edu/display/fisid_102860) Professor; PhD, University of Oklahoma Norman Campus

Axelrad, Penina (https://experts.colorado.edu/display/fisid_100792) Professor; PhD, Stanford University

Biringen, Sedat (https://experts.colorado.edu/display/fisid_105974) Professor; DSc, Universite Libre de Bruxelles (Belgium)
Bosanac, Natasha (https://experts.colorado.edu/display/fisid_158199)
Assistant Professor; PhD, Purdue University

Brasseur, James Gordon (https://experts.colorado.edu/display/fisid_156801)
Research Professor; PhD, Stanford University

Braun, Robert D. (https://experts.colorado.edu/display/fisid_158523)
Professor; PhD, Stanford University

Cash, Webster C (https://experts.colorado.edu/display/fisid_141893)
Professor; PhD, University of California-Berkeley

Chu, Xinzhao (https://experts.colorado.edu/display/fisid_141893)
Professor; PhD, Peking Univ (China)

Clark, Torin K (https://experts.colorado.edu/display/fisid_155959)
Assistant Professor; PhD, Massachusetts Institute of Technology

Correll, Nicolaus J (https://experts.colorado.edu/display/fisid_147555)
Assistant Professor; PhD, Ecole Polytech Federale de Lausanne (Switzerland)

Culp, Robert D.
Professor Emeritus

Doostan, Alireza (https://experts.colorado.edu/display/fisid_147382)
Associate Professor; PhD, Johns Hopkins University

Emery, William J (https://experts.colorado.edu/display/fisid_106038)
Professor; PhD, University of Hawaii at Manoa

Evans, John A (https://experts.colorado.edu/display/fisid_152970)
Assistant Professor; PhD, University of Texas at Austin

Farnsworth, John A (https://experts.colorado.edu/display/fisid_153255)
Assistant Professor; PhD, Rensselaer Polytechnic Institute

Felippa, Carlos A (https://experts.colorado.edu/display/fisid_105701)
Professor; PhD, University of California-Berkeley

Forbes, Jeffrey M (https://experts.colorado.edu/display/fisid_100264)
Research Professor, Professor Emeritus; PhD, Harvard University

Frew, Eric W (https://experts.colorado.edu/display/fisid_134685)
Associate Professor; PhD, Stanford University

Gerren, Donna Sue (https://experts.colorado.edu/display/fisid_108563)
Senior Instructor; PhD, University of Kansas

Hamlington, Peter Edward (https://experts.colorado.edu/display/fisid_149800)
Assistant Professor; PhD, University of Michigan Ann Arbor

Hauser, John (https://experts.colorado.edu/display/fisid_102555)
Associate Professor; PhD, University of California at Berkeley

Hieb, Rick
Scholar In Residence

Humbert, James Sean (https://experts.colorado.edu/display/fisid_156202)
Associate Professor; PhD, California Institute of Technology

Hussein, Mahmoud Ismail (https://experts.colorado.edu/display/fisid_144300)
Associate Professor; PhD, University of Michigan Ann Arbor

Jackson, Jelliffe
Instructor; PhD, University of Florida

Jansen, Kenneth E (https://experts.colorado.edu/display/fisid_147360)
Professor; PhD, Stanford University

Jones, Brandon A (https://experts.colorado.edu/display/fisid_149418)
Asst Professor Adjunct; PhD, University of Colorado

Kantha, Lakshmi H (https://experts.colorado.edu/display/fisid_100231)
Professor; PhD, Massachusetts Institute of Technology

Klaus, David M (https://experts.colorado.edu/display/fisid_107103)
Professor; PhD, University of Colorado Boulder

Knipp, Delores Jane (https://experts.colorado.edu/display/fisid_147655)
Research Professor; PhD, University of California-Los Angeles

Koster, Jean N.
Professor Emeritus

Larson, Kristine M (https://experts.colorado.edu/display/fisid_105437)
Professor; PhD, University of California-San Diego

Lawrence, Dale A (https://experts.colorado.edu/display/fisid_104057)
Professor; PhD, Cornell University

Leben, Robert R (https://experts.colorado.edu/display/fisid_105118)
Research Professor Emeritus; PhD, University of Colorado Boulder

Li, Xinlin (https://experts.colorado.edu/display/fisid_100016)
Professor; PhD, Dartmouth College

Liu, Hanli
Assoc Professor Adjunct; PhD, University of Michigan

Lopez Jimenez, Francisco (https://experts.colorado.edu/display/fisid_157867)
Assistant Professor; PhD, California Institute of Technology

Marden, Jason R. (https://experts.colorado.edu/display/fisid_147582)
Associate Professor; PhD, University of California-Los Angeles

Marshall, David (https://experts.colorado.edu/display/fisid_158629)
Research Professor; PhD, Monash University, Australia

Marshall, Robert Andrew (https://experts.colorado.edu/display/fisid_155957)
Assistant Professor; PhD, Stanford University

Maslanik, James
Research Professor Emeritus

Matsuo, Tomoko (https://experts.colorado.edu/display/fisid_145041)
Assistant Professor; PhD, SUNY at Stony Brook

Maute, Kurt Karl (https://experts.colorado.edu/display/fisid_113875)
Professor; PhD, Univ of Stuttgart (Germany)

McGrath, Michael T (https://experts.colorado.edu/display/fisid_100133)
Professor Adjunct
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 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, nanomaterials and metamaterials. Lab project or tensile testing is included.

Requisites: Requires corequisite courses of APPM 1350 or MATH 1300 or APPM 1340 or APPM 1345 and CHEN 1310 or ECEN 1310 or CSCI 1300 or CSCI 1310 or CSCI 1320. Restricted to Aerospace Engineering (ASEN) majors only.

Grading Basis: Letter Grade

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

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

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

Additional Information: Departmental Category: Aerospace Design and System Engineering

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.

Requisites: Restricted to Space Minor students only.

Grading Basis: Letter Grade

Additional Information: Departmental Category: Specialized Courses

ASEN 2001 (4) Aerospace 1: Introduction to Statics, Structures, and Materials
Introduces models and analytical/numerical methods for statics and structural analysis. Topics include force/moment equilibrium, truss analysis, beam theory, stress/strain, failure criteria, and structural design. Matlab proficiency required. Offered fall only.

Requisites: Requires prereqs PHYS 1110 APPM 1360 or MATH 2300 CSCI 1300 or 1310 or 1320 or CHEN 1310 or ECEN 1310 (all minimum grade C). Requires coreqs ASEN 2002 2012 APPM 2350 or MATH 2400. Restricted to (ASEN) mjrs

Additional Information: Departmental Category: Structures, Materials, and Structural Dynamics
ASEN 2002 (4) Aerospace 2: Introduction to Thermodynamics and Aerodynamics
Introduces the fundamental principles and concepts of thermodynamics and fluid dynamic systems. Emphasizes the synthesis of basic science (physics), mathematics and experimental methods that form the basis for quantitative and qualitative analyses of general aerospace technology systems. Proficiency in Matlab required. Offered fall only.
**Requisites:** Requires prerequisite courses of ASEN 2001 and ASEN 2012 and APPM 2350 or MATH 2400 (all minimum grade C). Requires corequisite courses of APPM 2360 and ASEN 2004. Restricted to Aerospace Engineering (ASEN) majors.
**Additional Information:** Departmental Category: Thermodynamics and Heat Transfer

ASEN 2003 (5) Aerospace 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. Class includes experimental and design laboratory exercises for aerospace applications of dynamic principles. Offered spring only.
**Requisites:** Requires prerequisite courses of ASEN 2001 and ASEN 2012 and APPM 2350 or MATH 2400 (all minimum grade C). Requires corequisite courses of APPM 2360 and ASEN 2004. Restricted to Aerospace Engineering (ASEN) majors only.
**Additional Information:** Departmental Category: Structures, Materials, and Control Systems Engineering

ASEN 2004 (5) Aerospace 4: Aerospace Vehicle Design and Performance
Introduction to design and analysis of aircraft and spacecraft. Aircraft topics include cruise performance, wing design, propulsion, stability, control, and structures. Spacecraft topics include rocket staging, orbit selection, launch systems, and spacecraft subsystems. Includes laboratory experiments and team design exercises. Offered spring only.
**Requisites:** Requires prerequisite courses of ASEN 2001 and ASEN 2012 and APPM 2350 or MATH 2400 (all minimum grade C). Requires corequisite courses of APPM 2360 and ASEN 2003. Restricted to Aerospace Engineering (ASEN) majors only.
**Additional Information:** Departmental Category: Aerospace Design and System Engineering

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. Offered fall only.
**Requisites:** Requires prerequisite courses of PHYS 1110 and APPM 1360 or MATH 2300 CSCI 1300 or 1310 or 1320 or CHEN 1310 or ECEN 1310 (all minimum grade C). Requires corequisite courses of APPM 2360 and ASEN 2003. Restricted to Aerospace Engineering (ASEN) majors.
**Additional Information:** Departmental Category: Aerospace Design and System Engineering

ASEN 2519 (1-6) 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 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 manned 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 3111 (4) Aerodynamics
Develops the fundamental concepts of aerodynamics and provides a working knowledge for their application to the design of aircraft and launch vehicles operating at various speeds and altitudes, as well as the atmospheric forces on satellites. Offered fall only.
**Requisites:** Requires prerequisite courses of ASEN 2002 and ASEN 2004 and APPM 2360 and APPM 2350 or MATH 2400 (all minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.
**Additional Information:** Departmental Category: Aerodynamics and Fluid Mechanics

ASEN 3112 (4) 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. Offered fall only.
**Requisites:** Requires prerequisite courses of ASEN 2001 and ASEN 2003 and ASEN 2004 and APPM 2360 and APPM 2350 or MATH 2400 (all minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.
**Additional Information:** Departmental Category: Structures, Materials, and Control Systems Engineering

ASEN 3113 (4) Thermodynamics and Heat Transfer
Focuses on the applications of the first and second laws of thermodynamics to control volumes and teaches the fundamental concepts of different modes of energy and heat transfer. Learn to use these concepts in gas dynamics, high-speed vehicle spacecraft design, environmental systems, and energy analysis. Offered fall only.
**Requisites:** Requires prerequisite courses of ASEN 2002 and APPM 2360 and APPM 2350 or MATH 2400 (all minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.
**Additional Information:** Departmental Category: Thermodynamics and Heat Transfer
ASEN 3116 (3) Introduction to Biomedical Engineering
Addresses human responses to environment and physical stimuli. Makes use of engineering and physical principles in the study of human dynamics, arriving at reasonable solutions to 15 major areas of biomedical consent. Instructor consent required.

Additional Information: Departmental Category: Bioastronautics and Microgravity Science

ASEN 3128 (4) Aircraft Dynamics
Develops the fundamental concepts of aircraft dynamics. Covers flight mechanics, performance, dynamics and control of aircraft and how they impact aircraft design. Offered spring only.

Requisites: Requires prerequisite courses of ASEN 2002 and ASEN 2003 and ASEN 2004 and APPM 2360 (all minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.

Additional Information: Departmental Category: Aerospace Design and System Engineering

ASEN 3200 (4) Orbital Mechanics/Attitude Dynamics and Control
Presents the fundamentals of orbital mechanics, 3D rigid body dynamics and satellite attitude dynamics and controls. Offered spring only.

Requisites: Requires prerequisite courses of ASEN 2003 and ASEN 2004 and APPM 2360 and APPM 2350 or MATH 2400 (all minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.

Additional Information: Departmental Category: Astrodynamics and Orbital Mechanics

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. Offered spring only.

Requisites: Requires prerequisite courses of ASEN 2003 and PHYS 1120 and APPM 2360 (all minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.

Additional Information: Departmental Category: Systems and Control

ASEN 3519 (1-4) 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. Departmental Category: Specialized Courses

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.

Grading Basis: Pass/Fail

Additional Information: Departmental Category: Specialized Courses

ASEN 4010 (3) Introduction to Space Dynamics
Includes central force fields, satellite orbits, rocket dynamics, orbital transfer, interplanetary mission analysis, and perturbation due to atmospheric drag and Earth oblateness.

Requisites: Requires prerequisite course of ASEN 3200 (minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.

Additional Information: Departmental Category: Astrodynamics and Orbital Mechanics

ASEN 4012 (3) Aerospace Materials
Studies aerospace grade aluminum, magnesium, nickel, and titanium alloys. Covers heat treatment, defect structures, failure mechanisms, corrosion and its prevention, the effect of space radiation on materials, and high and low temperature effects. Introduces composite materials with a lab design and experiment. Emphasizes the selection of materials in design with procedures for choosing materials rationally. Case studies include aerogels, carbides, composites, powder metallurgy, nanomaterials, and advanced materials manufacturing technologies.

Requisites: Requires prerequisite course of ASEN 2001 (minimum grade C). Restricted to Aerospace Engineering (ASEN) or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.

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

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 3113 and APPM 2360 (all minimum grade C). Restricted to Aerospace Engineering (ASEN) or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.

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: Requires prereq courses of ASEN 1022, 3111, 3112, 3113, 3128, 3200 and 3300 (all min grade C). Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Aerospace Engr (ASEN) Aerospace or Engr-Concurrent Degree (C-ASEN) students majors only

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. Department consent required. Offered spring only.

Requisites: Requires prerequisite course of ASEN 4018 (minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.

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 CSCI 1320 or ECEN 1310 or CHEN 1310 (minimum grade C). Restricted to Aerospace Engineering (ASEN) or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.

Additional Information: Departmental Category: Computational and Analytic Methods
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: Global Positioning Systems

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 (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 4215 (3) Descriptive Physical Oceanography
Introduces descriptive and dynamical physical oceanography, focusing on the nature and dynamics of ocean currents and their role in the distribution of heat and other aspects of ocean physics related to the Earth's climate. Dynamical material limited to mathematical descriptions of oceanic physical systems.
Equivalent - Duplicate Degree Credit Not Granted: ASEN 5215 and ATOC 4215 and ATOC 5215
Requisites: Restricted to students with 87-180 credits (Seniors) or graduate students only.
Additional Information: Departmental Category: Atmospheric, Oceanic, and Space Sciences

ASEN 4216 (3) Neural Signals and Functional Brain Imaging
Explores bioelectric and metabolic signals generated by the nervous system from two stand points: 1) their biophysical genesis and role in neural integration and 2) neurotechnologies such as electroencephalography, magnetoencephalography, deep brain stimulation and functional magnetic resonance imaging.
Equivalent - Duplicate Degree Credit Not Granted: ASEN 5216 and ECEN 4811
Requisites: Requires prerequisite course of ASEN 3300 or ECEN 2260 or ECEN 3030 (all minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.
Additional Information: Departmental Category: Bioastronautics and Microgravity Science

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 4222 (3) Materials Science for Composite Manufacturing
Studies common matrix materials and the modifications and improvements of properties which can be achieved by adding second phase reinforcements. Properties will be significantly affected by the design approach and by requirements, and by the procedure of adding reinforcements. Investigates polymer, ceramic and metallic materials. Explores manufacturing, fabrication and processing techniques. Evaluates future developments.
Equivalent - Duplicate Degree Credit Not Granted: ASEN 5222
Requisites: Requires prerequisite course of ASEN 3112 and prerequisite or corequisite course of ASEN 4012 (all minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.
Additional Information: Departmental Category: Structures, Materials, and Structural Dynamics
ASEN 4238 (3) Computer-Aided Control Systems Design
Covers Matlab and Simulink software, and multivariable control system synthesis and analysis techniques for typical aerospace control problems. Students formulate control problems and synthesize control functions using linear quadratic techniques. Includes numerical integration of differential equations and nonlinear simulation of orbit and attitude dynamics.

**Requisites:** Requires prerequisite course of APPM 2360 (minimum grade C).

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

ASEN 4248 (3) Computer-Aided Control System Design 2
Studies theory and engineering applications of Kalman filter techniques. Covers discrete and continuous filters, the extended Kalman filter, and their application to guidance, navigation, and control, including satellite orbit and attitude problems, inertial and control navigation, and the Global Positioning System.

**Requisites:** Requires prerequisite course of ASEN 4238 (minimum grade C).

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

ASEN 4255 (3) Environmental Aerodynamics
A review of the properties and causes of hazards posed by the environment, ranging from atmospheric wind shear to tornadic flows. Involves a multidisciplinary approach combining analytical, numerical, scale modeling studies with extensive field measurements, wind energy and biophysical aerodynamics.

**Equivalent - Duplicate Degree Credit Not Granted:** ASEN 5255

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

**Additional Information:** Departmental Category: Atmospheric, Oceanic, and Space Sciences

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 4426 (3) Neural Systems and Physiological Control
A biophysical exploration of human physiology from the standpoints of control systems and neural information processing. Topics include: neural control of movement and cardiovascular performance, tissue growth and repair, carcinogenesis, and physiological responses to microgravity.

**Equivalent - Duplicate Degree Credit Not Granted:** ASEN 5426 and ECEN 4821 and ECEN 5821

**Requisites:** Requires prerequisite course of ASEN 3300 or ECEN 2260 or ECEN 3030 (minimum grade C). Restricted to Aerospace Engineering (ASEN) majors only.

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

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 (1-6) Independent Study
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 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