AEROSPACE ENGINEERING (ASEN)

Courses

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 2.0 total credit hours.
Requisites: Restricted to Undergraduate Aerospace (ASEN-BSAE) or Undergraduate Engineering Open Option majors only.

ASEN 1030 (3) Introduction to Computing for Aerospace Engineering
Develop a foundational understanding of computational thinking required to approach engineering challenges with systematic problem-solving skills. By the end of this class, students will be able to apply computational thinking principles to design, implement, and debug programs using a high-level programming language. Additionally, students will demonstrate proficiency in fundamental programming concepts, including variables, control structures, arrays, and functions, while also showcasing the ability to analyze problems, decompose them into smaller tasks, and devise algorithmic solutions.
Requisites: Requires a prerequisite or corequisite course APPM 1340 or APPM 1345 or APPM 1350 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 75 credit hours or less completed.
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 75 credits or less 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 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 1030 or 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 APPM 2360 or MATH 2130 and 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 ASEN 1030 or 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 ASEN 1030 or 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 10.0 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 9.0 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 Technical 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 Technical 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 prereqs ASEN 2403 or MCEN 2043 or CVEN 3111 and APPM 2350 or MATH 2400 and APPM 2360 or MATH 2130 MATH 3430.

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 prereqs ASEN 2403 or MCEN 2043 or CVEN 3111 and APPM 2360 or MATH 2130 MATH 3430 and PHYS 1120

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 9.0 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 prereq courses 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. Degree credit not granted for MCEN 4138 and MCEN 5138 and ECEN 4138 and ECEN 5138.
Equivalent - Duplicate Degree Credit Not Granted: ASEN 5114
Requisites: Requires prereq courses ASEN 3128 or ASEN 3728 and ASEN 3200 or ASEN 3700 (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, OR IDEN majors with an Aero emphasis.
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 4402 (3) Aerospace Materials and Structural Analysis
Reviews essential concepts normally covered in undergraduate solid mechanics or mechanics of materials courses, such as concepts of stress and strain in two dimensions and three-dimensional systems. Covers more advanced topics such as structural instabilities and vibrations, materials classification and basic properties, viscoelastic and plastic material behavior and commonly used ductile failure theories. Introduces the finite-element (FE) method to analyze complex geometries and exposes students to methods utilized extensively by companies engaged in structural design.
Requisites: Requires prerequisite courses of ASEN 3401 and MCEN 1024 or CHEN 1201 or CHEN 1211 or CHEM 1113 or CHEM 1400 (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 6.0 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 6.0 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 6.0 total credit hours. Allows multiple enrollment in term.
Additional Information: Departmental Category: Specialized Courses

ASEN 5007 (3) Introduction to Finite Elements
Introduces finite element methods used for solving linear problems in structural and continuum mechanics. Covers modeling, mathematical formulation, and computer implementation.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite matrix algebra.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Structures, Materials, and Structural Dynamics

ASEN 5010 (3) Spacecraft Attitude Dynamics and Control
Includes rigid body kinematics and spacecraft attitude descriptions, torque-free attitude dynamics, static attitude determination, motion and stability due to gravity gradient torque and spinning craft, passive and active methods of attitude control, nonlinear regulator and attitude tracking feedback controlaws.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 3200, ASEN 3700, or equivalent and good knowledge of linear algebra, vector calculus, basics of ordinary differential equations.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Astrodynamics and Orbital Mechanics

ASEN 5012 (3) Mechanics of Aerospace Structures
Applies fundamental concepts of continuum mechanics, theory of elasticity and energy methods to the analysis of structures.
Equivalent - Duplicate Degree Credit Not Granted: MCEN 5023
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN) majors, and Aerospace graduate certificate students.
Recommended: Prerequisites APPM 2360 and ASEN 2001 or 2701 and ASEN 2003 or 2703 and ASEN 3112 or 3712 or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Structures, Materials, and Structural Dynamics

ASEN 5014 (3) Linear Control Systems
Introduces the theory of linear systems, including vector spaces, linear equations, structure of linear operators, state space descriptions of dynamic systems, and state feedback control methods.
Equivalent - Duplicate Degree Credit Not Granted: ECEN 5448 and MCEN 5448
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 3200, ASEN 3700, or equivalent or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Systems and Control

ASEN 5016 (3) Space Life Sciences
Familiarizes students with factors affecting living organisms in the reduced-gravity environment of space flight. Covers basic life support requirements, human physiological adaptations, and cellular-level gravity dependent processes with emphasis on technical writing and research proposal preparation.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Bioastronautics and Microgravity Science

ASEN 5018 (3) Graduate Projects I
Exposes MS and PhD students to project management and systems engineering disciplines while working a complex aerospace engineering project as part of a project team. The project team may perform some or all of the following project activities during this first semester of the two-semester course sequence: requirements, definition, design and design review, build, test, and verification.
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.
Recommended: Prerequisite ASEN 4138 or ASEN 5148 or ASEN 5158 or instructor consent required.

ASEN 5022 (3) Dynamics of Aerospace Structures
Applies concepts covered in undergraduate dynamics, structures and mathematics to the dynamics of aerospace structural components, including methods of dynamic analysis, vibrational characteristics, vibration measurements and dynamic stability.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 5012 or ASEN 5227 or MATH 2130 or APPM 3310 or equivalent or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Structures, Materials, and Structural Dynamics

ASEN 5034 (3) Stochastic Methods for Systems Engineering
Development of stochastic models used in aerospace and other systems engineering and optimization problems. Review of probability theory, stochastic models used in decision theory, random processes, queuing theory, information theory, reliability and quality control. Computer solutions required.
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.
Additional Information: Departmental Category: Aerospace Design and System Engineering

ASEN 5044 (3) Statistical Estimation for Dynamical Systems
Introduces theory and methods of statistical estimation for general linear and nonlinear dynamical systems, with emphasis on aerospace engineering applications. Major topics include: review of applied probability and statistics; optimal parameter and dynamic state estimation; theory and design of Kalman filters for linear systems; extended/unscented Kalman filters and general Bayesian filters for non-linear systems.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Systems and Control

ASEN 5047 (3) Probability and Statistics for Aerospace Engineering Sciences
Considers probability concepts and theory for better design and control of aerospace engineering systems. Includes descriptive and inferential statistical methods for experimental analysis. Covers discrete and continuous random variable distributions, estimators, confidence intervals, regression, analysis of variance, hypothesis testing, nonparametric statistics, random processes and quality control, including software models of same.
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.
Additional Information: Departmental Category: Computational and Analytic Methods

ASEN 5050 (3) Space Flight Dynamics
Includes celestial mechanics, space navigation, and orbit determination; trajectory design and mission analysis trajectory requirements; and orbital transfer and rendezvous.
Equivalent - Duplicate Degree Credit Not Granted: ASEN 5052
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 3200 or ASEN 3700 or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Astrodynamics and Orbital Mechanics

ASEN 5051 (3) Fundamentals of Fluid Dynamics
Highlights physical properties of gases and liquids; kinematics of flow fields; and equations describing viscous, heat-conducting Newtonian fluids. Emphasizes exact solutions and rational approximations for low and high speed dissipative flows, surface and internal waves, acoustics, stability, and potential flows.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 3111 or ASEN 3711 (minimum grade B) or an equivalent course.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Aerodynamics and Fluid Mechanics

ASEN 5052 (3) Analytical Astrodynamics
Introduction to astrodynamics with an emphasis on analytical approaches. The primary subjects covered are the general solution of the 2-body problem; orbital trajectories, transfers, targeting, and time of flight; orbit perturbations and averaging analysis; and the restricted 3-body problem. Previously offered as a special topics course.
Equivalent - Duplicate Degree Credit Not Granted: ASEN 5050
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 3200 or 3700 or instructor consent required.
Grading Basis: Letter Grade

ASEN 5053 (3) Space Propulsion
This course is designed to teach the theory, analysis and design of modern space propulsion systems. Lectures describe the thermodynamics of rocket propulsion and nozzle flow theory, followed by in#depth study of cold gas thrusters, monopropellant and bipropellant liquid rockets, solid and hybrid rockets, electric propulsion, nuclear rockets, and solar sails. If time permits, other exotic propulsion technologies will be dealt with.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Thermodynamics and Propulsion

ASEN 5067 (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 4067
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors only.
Grading Basis: Letter Grade

ASEN 5090 (3) Introduction to Global Navigation Satellite Systems
Global Navigation Satellite Systems (GNSS) are important tools for navigation, science, and engineering. Introduces GNSS hardware, signal structure, algorithms, error sources, and modeling techniques. Programming experience is required.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Global Positioning Systems

ASEN 5098 (3) System Engr and Design
Additional Information: Departmental Category: Aerospace Design and System Engineering

ASEN 5111 (3) Introduction to Aeroelasticity
Introduces static and dynamic aeroelasticity of airfoils and wings. Covers the classical aeroelasticity theory and introduces computational methods for aeroelastic problems.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 3111 or ASEN 3711 and MATH 2130 or APPM 3310 and MATH 3430 or equivalent or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Structures, Materials, and Structural Dynamics

ASEN 5114 (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. Degree credit not granted for MCEN 4138 and MCEN 5138 and ECEN 4138 and ECEN 5138.
Equivalent - Duplicate Degree Credit Not Granted: ASEN 4114
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.
Recommended: Prerequisites Undergraduate systems or control course or instructor consent (ASEN 3128 or ASEN 3728 or ASEN 3200 or ASEN 3700).
Additional Information: Departmental Category: Systems and Control

ASEN 5121 (3) Boundary Layers and Convection
This course presents an introduction to the principles of viscous fluid flow and methods for performing engineering calculations of quantities such as skin friction and heat transfer rates in boundary layers. The first portion of the course material will focus on basic principles of fluid mechanics. We will derive the Navier-Stokes equations and discuss some simple solutions to these equations. The second portion of the course will concentrate on the application of these principles to boundary layers. We will derive the boundary layer equations and discuss their approximate and almost exact solutions. Formerly offered as a special topics course.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 3111 and/or ASEN 5051.
Grading Basis: Letter Grade

ASEN 5122 (3) Control of Aerospace Structures 1
Introduces the basic problems in dynamic modeling and active control of large spacecraft and satellites. Includes system descriptions, model reduction, controller design, and closed-loop stability analysis.
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.
Recommended: Prerequisite ASEN 3200 or equivalent or instructor consent required.
Additional Information: Departmental Category: Structures, Materials, and Structural Dynamics

ASEN 5128 (3) Small Uncrewed Aircraft System Guidance, Navigation, and Control
Introduce students to advanced techniques for guidance, navigation, and control of the emerging class of small uncrewed aircraft systems (SUAS), which are informally defined as aircraft that weight less than 55 lbs.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN) majors, and Aerospace graduate certificate students.
Recommended: Prerequisites ASEN 5014 Linear Systems or similar OR ASEN 5044 Estimation or similar.
Grading Basis: Letter Grade

ASEN 5131 (3) Introduction to Hypersonics
Introduces key elements of hypersonic vehicles, including trajectories, surface heating, propulsion, and thermal protection systems. Provides the necessary background on fluid dynamics and boundary layers, so students from a variety of disciplines are welcome. Also covers thermochemical nonequilibrium, surface pressure, and aerodynamic forces. Includes a mix of empirical techniques and computational analyses. Requires basic programming experience and exposure to partial differential equations.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade

ASEN 5137 (3) Experimental Design and Statistical Methods
Examines the applied issues of designing experiments and performing statistical analysis to reach justified scientific conclusions. Approaches are integrated to enable application to real-world research questions, with a focus on the unique challenges of human subject experiments.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: to Aerospace and Biomedical Engineering students.
Grading Basis: Letter Grade

ASEN 5148 (3) Spacecraft Design
Integrates the design elements and fundamental analyses necessary to complete the conceptual (Phase A) design of an unmanned spacecraft. Lecture and discussion explore mission design, propulsion, power, structure, thermal, attitude control, communication, command, and data handling and attitude control systems. The role of project management and systems engineering are examined. Resource estimating and lessons learned in satellite programs are reviewed.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Aerospace Design and System Engineering

ASEN 5151 (3) Fundamentals of Gas Dynamics
Presents the fundamental topics of gas dynamics, focusing on compressible flows but providing connections to incompressible topics. Topics include analysis of quasi-one-dimensional flow, the partial differential equations governing inviscid compressible flows, linearized flow theory, supersonic flow around cones, and the method of characteristics applied to both steady two-dimensional supersonic flows, and unsteady one-dimensional flows.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 3111 or equivalent.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Aerodynamics and Fluid Mechanics

ASEN 5158 (3) Space Habitat Design
Utilize systems engineering methods to design and analyze a spacecraft intended for human occupancy with functional knowledge of the technologies used to sustain life. Emphasis placed on deriving requirements from stated mission goals and objectives, developing integrated functional schematics into a conceptual design, and analyzing design options by mass/volume estimation, including launch vehicle selection.
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors only.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Aerospace Design and System Engineering

ASEN 5212 (3) Composite Structures and Materials
Develops the macromechanical and micromechanical theory of the elastic behavior and failure of composite laminates. Applies basic theory to a broad range of practical problems including the buckling and vibration of composite plates, columns, and shells.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Structures, Materials, and Structural Dynamics

ASEN 5218 (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 4218
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors only.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Aerospace Design and System Engineering

ASEN 5222 (3) Materials Science for Composite Manufacturing
Studies common matrix materials and the modificationsand 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 4222
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors only.
Recommended: Prerequisites ASEN 3112 or ASEN 3712 and ASEN 4012 or equivalent or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Structures, Materials, and Structural Dynamics

ASEN 5226 (3) Medicine in Space and Surface Environments
Introduces concepts of space medicine and provides a focused analysis on exploration medical capabilities. This course provides a unique learning opportunity to understand the medical challenges of human spaceflight. This is done both in the classroom and in an immersive field simulation that allows students to engage in medical care in simulated planetary surface environments. As such, it also introduces students to important concepts in human spaceflight operations which are difficult to teach in the classroom.

ASEN 5235 (3) Introduction to Atmospheric Radiative Transfer and Remote Sensing
Examines fundamentals of radiative transfer and remote sensing with primary emphasis on the Earth's atmosphere; emission, absorption and scattering by molecules and particles; multiple scattering; polarization; radiometry and photometry; principles of inversion theory; extinction- and emission-based passive remote sensing; principles of active remote sensing; lidar and radar; additional applications such as the greenhouse effect and Earth's radiative energy budget.
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors only.
Recommended: Prerequisite one year of calculus-based physics and math up through differential equations.
Additional Information: Departmental Category: Remote Sensing

ASEN 5245 (3) Radar and Remote Sensing
Examines active techniques of remote sensing, with emphasis on radar fundamentals, radar wave propagation, scattering processes, and radar measurement techniques and design. Examines specific radar systems and applications, such as synthetic aperture radar phased arrays for atmosphere, space, land, and sea applications.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Remote Sensing

ASEN 5251 (3) Molecular Thermodynamics and Kinetics
Provides an introduction to chemical kinetics and theories of molecular collisions and chemical reactions. Draws on quantum mechanics, statistical mechanics, and thermodynamics to help understand the magnitude of chemical reaction rates and how they vary with macroscopic parameters, such as temperature, and with microscopic parameters, such as molecular size, structure, and energy spacing.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite general chemistry, general physics, multivariable calculus.
Grading Basis: Letter Grade

ASEN 5254 (3) Algorithmic Motion Planning
Overview of the lessons learned by the robot motion planning community in the recent years. Examines approaches based on potential functions, graphs, sampling methods, task and motion planning, and basic approaches to planning under uncertainty. Provides a set of tools to tackle new problems and enables the pursuit of complex research questions such as planning for autonomous systems.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisites or corequisites: ASEN 5014 or equivalent, knowledge of how to plot 2-D/3-D functions, arrays and other data structures, standard constructs (loops, functions, etc), C++, Python or MATLAB, and knowledge of differential equations and linear algebra.
Grading Basis: Letter Grade

ASEN 5264 (3) Decision Making under Uncertainty
Covers algorithms for optimal sequential decision making in the presence of uncertainty. Mathematical formalisms include the Markov decision process (MDP), partially observable Markov decision process (POMDP), and Games. Solution techniques include exact dynamic programming, Monte Carlo tree search, deep reinforcement learning, and alpha vector value approximation for POMDPs. Assignments require programming in a high level language (Julia as of 2023). Previously offered as a special topics course.
Equivalent - Duplicate Degree Credit Not Granted: CSCI 5264
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite fluency in a high-level programming language, willingness to learn another language if required for homework assignments and basic understanding of probability.
Grading Basis: Letter Grade

ASEN 5307 (3) Engineering Data Analysis Methods
Gives students broad exposure to a variety of traditional and modern statistical methods for filtering and analyzing data. Topics include estimation methods, principal component analyses and spectral analyses. Introduces these methods and provides practical experience with their use. Students carry out problem assignments.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Computational and Analytic Methods

ASEN 5325 (3) Small Scale Processes in Geophysical Fluids
Provides an overview of mixing and wave processes in the oceans and the atmosphere. Topics include turbulent boundary layers in the lower atmosphere and the upper ocean, air-sea interactions, and surface and internal waves.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Atmospheric, Oceanic, and Space Sciences

ASEN 5335 (3) Aerospace Environment
Examines the components of the solar-terrestrial system and their interactions to provide an understanding of the re-entry and orbital environments within which aerospace vehicles operate. Includes the sun, solar wind, magnetospere, ionosphere, thermosphere, radiation belts, energetic particles, comparative environments (Mars, Venus, etc.), orbital debris, spacecraft charging, particle effects on systems, shielding, and satellite drag.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite Senior or graduate standing in engineering or related physical sciences.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Atmospheric, Oceanic, and Space Sciences

ASEN 5347 (3) Math Methods in Dynamics
Two-part graduate-level course on dynamics. Covers both flexible and rigid multibody analytical dynamics and finite element method for dynamics. Emphasizes formulations that naturally lead to easy computer implementation and stability, linearization, and modern rotational kinematics. Department consent required.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Structures, Materials, and Structural Dynamics

ASEN 5440 (3) Mission Design and Development for Space Sciences
Brings science and engineering students together to develop the multidisciplinary skills required to create a successful proposal to develop a NASA-funded small space mission. Goals: 1) develop the proposal science objectives based on scientific community priorities and NASA Announcement of Opportunity. 2) Understand how science requirements lead to the design of instrumentation. 3) Understand practical aspects of mission development.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 5780
Requisites: Restricted to College of Engineering (ENGR) graduate students, Department of Astrophysical and Planetary Sciences graduate students or Aerospace Engineering Concurrent Degree (C-ASEN and ASEN-P) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Aerospace Design and System Engineering

ASEN 5506 (1-2) Bioastronautics Seminar
Focuses on current topics related to space habitat systems design and research aimed at understanding the effects of spaceflight on living organisms ranging from humans down to microbes. Literature analysis and scientific presentations are expected. Emphasis is on biophysical mechanisms, comprehensive models, and related technology development.
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.
Additional Information: Departmental Category: Bioastronautics and Microgravity Science

ASEN 5519 (1-3) Special Topics
Reflects upon specialized aspects of aerospace engineering sciences. Course content is indicated in the online Class Search.
Repeatable: Repeatable for up to 9.0 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors only.
Recommended: Prerequisite varies.
Additional Information: Departmental Category: Specialized Courses

ASEN 5849 (1-6) Independent Study
Study of special projects.
Repeatable: Repeatable for up to 6.0 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Specialized Courses

ASEN 5940 (1-3) Engineering Research Internship
Grants credit to foreign visiting graduate students for conducting research within the Aerospace Engineering Sciences department. Credits can be transferred to the student's home institution. CU-Boulder students may also receive credit for conducting research outside of the university, either overseas or in the US.
Repeatable: Repeatable for up to 6.0 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Specialized Courses

ASEN 6008 (3) Interplanetary Mission Design
Exploration of principles and methods related to the design and construction of trajectories for interplanetary mission design. Some topics covered include: two-and three-body motion, gravity assists, maneuver computation, navigation, numerical integration, and construction of orbits. The main focus is on simple ballistic mission designs, such as Galileo or Cassini, however, libration point trajectories will also be covered.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 5050 or ASEN 5052.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Astrodynamics and Orbital Mechanics

ASEN 6009 (1-2) Special Topics Seminar
Presents research and developments in each department's focus areas.
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN) majors only.
Additional Information: Departmental Category: Specialized Courses

ASEN 6010 (3) Advanced Spacecraft Dynamics and Control
Studies the dynamic modeling and control of spacecraft containing multiple momentum exchange devices, and/or flexible spacecraft components. Will develop nonlinear feedback control algorithms, explore singularity avoidance strategies. The second half of the course derives analytical methods (D'Alembert's equations, Lagrange's equations, Boltzmann Hamel equations) to model a hybrid rigid/flexible spacecraft system.
Requisites: Requires prerequisite course of ASEN 5010 (minimum grade D-). Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Astrodynamics and Orbital Mechanics

ASEN 6011 (3) Experimental Fluid Mechanics
This course presents an intermediate level introduction into the theory and practice of performing experimental measurements in fluid mechanics. The fundamental principles and definitions associated with instrumentation, measurement procedures, data analysis, and uncertainty quantification will be discussed. A specific focus will be placed on the application of a variety of measurement techniques in low-speed aerodynamic environments. A selection of measurement techniques will be extensively studied and applied including: classical pressure and temperature measurements, thermal (hot-wire) anemometry, laser doppler anemometry, particle image velocimetry, surface and field flow visualization techniques, schlieren and shadowgraph photography techniques. Undergraduates may enroll with instructor permission. Previously offered as a special topics course.
Requisites: Requires prerequisite or corequisite course of ASEN 5051 (minimum grade D-). Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade

ASEN 6013 (3) High Speed Propulsion
Covers air-breathing and rocket propulsion cycles, their relative performance trade-offs, and how they fit within the context of a vehicle system. Specific emphasis will be placed on fundamental cycle analyses, component level design, and propulsion/airframe integration for rockets, turbojets, ramjets, scramjets, combined cycles, and other advanced propulsion concepts.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 4013 or equivalent or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Thermodynamics and Propulsion

ASEN 6014 (3) Spacecraft Formation Flying
Studies the dynamic modeling and control of spacecraft formations orbiting about a planet. Investigate linear and nonlinear relative motion descriptions, rectilinear and curvilinear coordinates, orbit element difference based descriptions, J2-invariant relative orbits, as well as Lyapunov-based relative motion control strategies.
Requisites: Requires prerequisite course of ASEN 5050 or ASEN 5052 (minimum grade B-). Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Systems and Control

ASEN 6015 (3) Space Vehicle Guidance and Control
The course gives a comprehensive view of guidance systems used in space vehicles, and methods for analyzing the performance of these systems. The types of guidance systems that will be covered are launch vehicle ascent, intercept/rendezvous, interplanetary, orbit station-keeping, atmospheric re-entry, lander, and low-thrust. The mathematical foundation of these systems will be derived and discussed. Real world applications will be presented by reviewing selections from published literature. Course work will emphasize the analysis of the guidance system performance to achieve stated goals. Previously offered as a special topics course.
Requisites: Requires prereqs ASEN 5014 and ASEN 5050 (min. grade D-). Restricted to Engineering graduate students, Aero Concurrent Degree (C-ASEN and C-ASENP) mjrs, Aero graduate certificate students.
Grading Basis: Letter Grade

ASEN 6020 (3) Optimal Trajectories
Introduces the theory and practice of trajectory optimization. The general theory behind optimization and optimal control will be introduced with an emphasis on the properties of optimal trajectories. The main application will be to space trajectories, but other applications will also be considered.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisites ASEN 5050 and ASEN 5014 or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Astrodynamics and Orbital Mechanics

ASEN 6024 (3) Nonlinear Control Systems
Introduces the analysis and control design methods for nonlinear systems, including Lyapunov, Describing Function, and Feedback Linearization methods.
Equivalent - Duplicate Degree Credit Not Granted: MCEN 5738 and ECEN 5738
Requisites: Requires prereq of ASEN 5014 (min. grade C). Restricted to Engineering graduate students, Aerospace Concurrent Degree (C-ASEN and C-ASENP) mjrs, Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Systems and Control

ASEN 6028 (3) Graduate Projects II
Exposes MS and PhD students to leadership positions in project management and systems engineering while working a complex aerospace engineering project as part of a project team. The project team may perform some or all of the following project activities during this second semester of the two-semester course sequence: requirements definition, design and design review, build, test, and verification.
Requisites: Restricted to College of Engineering (ENGR) graduate students or Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors only.
Recommended: Prerequisite ASEN 4138 or ASEN 5148 or ASEN 5018 or ASEN 5158 or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Aerospace Design and System Engineering

ASEN 6037 (3) Turbulent Flows
Studies turbulent closure methods and computational procedures used to solve practical turbulent flows. Emphasizes multi-equation models used with time-averaged equations to calculate free-turbulent shear-flows and turbulent boundary layers. Employs spectral methods in direct and large-eddy simulation of turbulence. Formerly ASEN 5037.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 5051 or equivalent or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Aerodynamics and Fluid Mechanics

ASEN 6044 (3) Advanced State Estimation
Introduces principles and techniques for designing, implementing, and analyzing probabilistic state estimators for dynamical systems that require going beyond traditional least-squares and Kalman filtering approaches. Emphasis on development of practical discrete-time Bayesian state space filtering algorithms for systems characterized by partial observability and non-Gaussian uncertainties, which arise in many applications governed by complex non-linear stochastic dynamics and measurement processes.
Requisites: Requires prerequisite ASEN 5044 (min grade B+). Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade

ASEN 6050 (3) Space Instrumentation
Provides an overview of the relevant space environment and process, the types of instruments flown on recent mission and the science background of the measurement principles.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 6050 and ERTH 6050
Requisites: Requires prerequisite course of ASEN 5335 (minimum grade D-).
Grading Basis: Letter Grade
Additional Information: Departmental Category: Aerospace Design and System Engineering

ASEN 6055 (3) Data Assimilation and Inverse Methods for Earth & Geospace Observations
Covers a selection of topics in probability theory, spatial statistics, estimation theory, numeric optimization, and geophysical nonlinear dynamics that form the foundation of commonly used data assimilation and inverse methods in the Earth and Space Sciences. Hands-on computational homework and projects provide opportunities to apply classroom curricula to realistic examples in the context of data assimilation.
Requisites: Requires prerequisite course of ASEN 5044 (minimum grade B-). Program requirement of CEAS graduate students OR Aerospace Graduate Certificate student.
Grading Basis: Letter Grade

ASEN 6060 (3) Advanced Astrodynamics
Covers Lagrangian and Hamiltonian formalisms for astrodynamics problems, the computation and characterization of space trajectories in highly dynamic environments, computation of periodic orbits, stability analysis of orbital motion, and development of analytical theories for dynamics.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 5050 or equivalent or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Astrodynamics and Orbital Mechanics

ASEN 6061 (3) Molecular Gas Dynamics and DSMC
Describes the composition and flow of gases on a microscopic level to examine the behavior of the molecules that make up a macroscopic flow system. Thermodynamic properties, transport phenomena, and the governing Boltzmann Equation are derived from molecular collision dynamics and the kinetic theory. The Direct Simulation Monte Carlo method is introduced with applications.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Aerodynamics and Fluid Mechanics

ASEN 6062 (3) Celestial Mechanics
Analysis of the N-body problem, the dynamical modeling of naturally gravitating systems and mathematical constraints on possible motions. Dynamical coupling between translational and rotational motion. Perturbation theory applied to the motion of spacecraft subject to these gravitational systems. Emphasis will be given to solar system dynamics and astrodynamics in the course.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 5050 or equivalent or instructor consent required.
Grading Basis: Letter Grade

ASEN 6070 (3) Satellite Geodesy
Focuses on the measurement of the Earth's gravitational field, rotational characteristics, and shape using Earth and space-based tracking of artificial satellites. Particular emphasis on satellite altimetry and satellite gravity measurements.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 3200, ASEN 3700, or equivalent or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Astrodynamics and Orbital Mechanics

ASEN 6080 (3) Statistical Orbit Determination
Course on orbit and advanced estimation techniques. Emphasizes orthogonal transformation techniques such as Givens and Householder, square root filtering and smoothing and considers covariance analysis. Also nonlinear filters and dynamic model compensation techniques. Requires term project that involves the application of many of the techniques required for precise orbit determination.
Requisites: Requires prerequisite course of ASEN 5044 (minimum grade D-). Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN) majors and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Astrodynamics and Orbital Mechanics

ASEN 6084 (3) Optical Multi-Target Tracking
This course focuses on exploiting sensor information to detect, track, and characterize unresolved objects using optical sensors. This course will cover phenomenological modeling, error statistics, image processing, detection methods, and several multi-object tracking frameworks. Assignments and projects will incorporate both simulated and empirical data generation / collection and reduction.
Requisites: Requires prereq ASEN 5044 (min. grade D-). Restricted to Engineering graduate students, Aero Concurrent Degree (C-ASEN and C-ASENP) mjrs, Aero graduate certificate students.
Grading Basis: Letter Grade

ASEN 6090 (3) Advanced Global Navigation Satellite Systems: Software and Applications
Focuses on high-precision applications of Global Navigation Satellite Systems (GNSS) and the software tools that are needed to achieve these precisions. Topics include precise orbital determination, reference frames, atmospheric delays, relativity, clock models, ambiguity resolution, and scientific applications.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 5090 or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Global Positioning Systems

ASEN 6091 (3) Global Navigation Satellite System (GNSS) Receiver Architecture
Investigates the overall architecture of satellite navigation receivers: including both the analog radio frequency conditioning (antenna to the analog-to-digital converter) and the various signal processing algorithms. Such treatment of the operation of the receiver will provide insight into the trade-offs that go into GNSS as well as the more broad generic spread spectrum receiver design.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 5090.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Global Positioning Systems

ASEN 6092 (3) GNSS for Remote Sensing of the Atmosphere, Ionosphere, and Earth Surface
Covers technologies that rely on GNSS signals for remote sensing applications. GNSS receiver signal processing techniques and GNSS signal propagation effects due to interactions with the ionosphere, neutral atmosphere, and Earth surface are addressed. Students will learn techniques to process GNSS measurements and to infer ionospheric, atmospheric, and Earth surface properties from real GNSS measurements collected by ground-based receivers and LEO satellites.
Requisites: Requires prerequisite course of ASEN 5090 (minimum grade D-). Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade

ASEN 6107 (3) Nonlinear Finite Element Methods
Continuation of ASEN 5007. Covers the formulation and numerical solution of nonlinear static structural problems by finite element methods. Emphasizes the treatment of geometric nonlinearities and structural stability.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 5007 or equivalent or instructor consent required.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Specialized Courses

ASEN 6114 (3) System Identification for Control
Explores methods for identification of models for physical processes which will be part of a feedback control system. Focuses on the interplay between robustness of control laws and the performance of identification methods. Covers time-domain and frequency-domain identification methods, using experimental simulations of control systems of interest to the class.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite ASEN 5014 or ASEN 5114.
Grading Basis: Letter Grade

ASEN 6116 (3) Spacecraft Life Support Systems
Study the environmental control and the life support systems and technologies that keep people alive and healthy in spacecraft and habitats. Students will learn about thermal control systems, air revitalization processes, water reclamation and treatment, waste handling and the reuse of materials, and food and nutrition. Expect to develop analytical models from first principles and perform hands-on laboratory experiments. Formerly ASEN 5116.
Requisites: Requires prereq ASEN 5158 (min. grade D-). Requires coreq ASEN 5016. Restricted to Engineering grad students, Aero Concurrent Degree (C-ASEN and C-ASENP) mjrs, Aero graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Bioastronautics and Microgravity Science

ASEN 6216 (3) Human Operation of Aerospace Vehicles
Examines the role, capabilities, and limitations of human operators in aerospace vehicles. Topics include theoretical models of human information processing and decision-making, physiological limitations of the human (particularly spatial orientation illusions), the design of display and control interfaces, and the evaluation of those interfaces for human interaction with complex aerospace systems.
Requisites: Requires prerequisite or corequisite course of ASEN 5158 (minimum grade D-). Restricted to College of Engineering (ENGR) graduate students.
Recommended: for aerospace and biomedical engineering students.
Grading Basis: Letter Grade

ASEN 6265 (3) Fundamentals of Spectroscopy for Optical Remote Sensing
Provides a comprehensive overview of the fundamentals of quantum physics, atomic spectroscopy, molecular spectroscopy and laser spectroscopy. Exposes students to the spectroscopy applications in modern optical and laser remote sensing. Assists students to develop the fundamental knowledge and skills for independent learning.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade

ASEN 6316 (3) Extravehicular Activity
Expose students to all aspects of extravehicular activity (EVA) to enable them to design systems to facilitate EVA for future human exploration. This course will draw upon the academic elements of design, engineering, technology development, physiology, operations, human-machine interaction, and geology to provide an interdisciplinary look at this topic.
Requisites: Requires prerequisite course of ASEN 5158 or ASEN 5016 (minimum grade D-). Restricted to College of Engineering (ENGR) graduate students and Aerospace graduate certificate students.
Recommended: aerospace or biomedical engineering students with a focus in bioastronautics.
Grading Basis: Letter Grade

ASEN 6331 (3) Computational Fluid Dynamics
Focuses on computational approaches to solve the Navier-Stokes equations. Assumes a basic knowledge of the solution of partial differential equations with numerical methods with focus finite element/volume methods (FEM/FVM but primarily FEM). These issues include: the discrete formulation, non-linear equation iterator, linear equation formation, boundary condition prescription and linear equation solution.
Requisites: Requires pre or coreqs ASEN 5007 and ASEN 5051 (minimum grade C). Restricted to Engineering graduate students, Aero Concurrent Degree (C-ASEN and C-ASENP) mjrs, Aero graduate certificate students.
Recommended: instructor permission required if pre/co requisite of ASEN 5007 and ASEN 5051 haven't been met.
Grading Basis: Letter Grade

ASEN 6337 (3) Remote Sensing Data Analysis
Covers some of the most commonly used machine learning techniques in remote sensing data analysis, specifically for clustering, classification, feature extraction and dimensionality reduction, and inverse methods used to retrieve geophysical information from remote sensing data. Hands-on computational homework and group and individual projects provide opportunities to apply classroom curricula to real remote sensing data.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Remote Sensing

ASEN 6365 (3) Lidar Remote Sensing
Provides a comprehensive, yet easily understandable, up-to-date understanding of lidar principles, technologies and applications. Contains approaches for quantitative lidar simulation, lidar sensitivity and error analysis, lidar data retrieval, lidar system design and performance analysis. Gives students opportunities to see and operate real state-of-the-art lidar systems and make connections to lidar experts in the nation and world.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Aerospace Design and System Engineering

ASEN 6412 (3) Uncertainty Quantification
This advanced topics course provides an exploration of techniques for representation and propagation of uncertainty in PDE/ODE-based systems.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisites APPM 5570 and ECEN 5612 (all minimum grade B) or equivalent courses with instructor consent.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Structures, Materials, and Structural Dynamics

ASEN 6519 (1-3) Special Topics
Reflects upon specialized aspects of aerospace engineering sciences. Course content is indicated in the online Schedule Planner.
Repeatable: Repeatable for up to 9.0 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to College of Engineering (ENGR) graduate students, Aerospace Engineering Concurrent Degree (C-ASEN and C-ASENP) majors, and Aerospace graduate certificate students.
Recommended: Prerequisite varies.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Specialized Courses

ASEN 6800 (3) Master of Engr Project
Repeatable: Repeatable for up to 6.0 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Specialized Courses

ASEN 6849 (1-6) Independent Study
Studies special projects agreed upon by student and instructor.
Repeatable: Repeatable for up to 6.0 total credit hours. Allows multiple enrollment in term.
Additional Information: Departmental Category: Specialized Courses

ASEN 6949 (1) Master's Candidate for Degree
Registration intended for students preparing for a thesis defense, final examination, culminating activity, or completion of degree.
Additional Information: Departmental Category: Specialized Courses

ASEN 6950 (1-6) Master's Thesis
Additional Information: Departmental Category: Specialized Courses

ASEN 8990 (1-10) Doctoral Dissertation
Additional Information: Departmental Category: Specialized Courses