SPEN - SPACE ENGINEERING (SPEN)

SPEN 201 Introduction to Space Engineering

Credits 3. 3 Lecture Hours. Broad overview and foundational knowledge of the key topics in Space Engineering; historical perspective on space exploration and the engineering advancements that have enabled deep space and planetary science missions, as well as human spaceflight and the commercial satellite industry; focuses on the unique characteristics of the space environment, which presents numerous challenges that drive the design of spacecraft systems; exploration of evolution of spacecraft system technology including power, communications, thermal control, life support, navigation, guidance, control and propulsion systems; emphasis on orbital mechanics, robotics, space architecture, and bioastronautics; topics include remote sensing, deep space propulsion, planetary defense, satellites, and end-to-end mission operations. **Prerequisites:** Grade of C or better in ENGR 102 and PHYS 206; grade of C or better in ENGR 216/PHYS 216 or PHYS 216/ENGR 216; grade of C or better in MATH 251 or MATH 253, or concurrent enrollment; Space Engineering majors.

SPEN 223 Fundamentals of Thermodynamics, Heat Transfer, and Fluid Mechanics for Space Engineering I

Credits 3. 3 Lecture Hours. Fundamentals of thermodynamics, heat transfer and fluid mechanics applied to space systems; concepts of energy, entropy, properties of liquids, vapors and mixtures; heat capacity of solids, liquids, vapors; heat conduction and radiation; fluid flows of relevance to habitats, biosystems, propulsion systems and atmospheres. **Prerequisites:** Grade of C or better in ENGR 102, PHYS 206, and SPEN 201; grade of C or better in ENGR 216/PHYS 216 or PHYS 216/ENGR 216; grade of C or better in MATH 251 or MATH 253, or concurrent enrollment; Space Engineering majors.

SPEN 324 Fundamentals of Thermodynamics, Heat Transfer, and Fluid Mechanics for Space Engineering II

Credits 3. 3 Lecture Hours. Continuation of SPEN 223; fundamentals of thermodynamics, heat transfer and fluid mechanics applied to space systems; concepts of energy, entropy, properties of liquids, vapors and mixtures; heat capacity of solids, liquids, vapors; heat conduction and radiation; fluid flows of relevance to habitats, biosystems, propulsion systems and atmospheres. **Prerequisites:** Grade of C or better in ENGR 102, PHYS 206, SPEN 201, and SPEN 223; grade of C or better in ENGR 216/PHYS 216 or PHYS 216/ENGR 216; grade of C or better in MATH 251 or MATH 253, or concurrent enrollment; Space Engineering majors.

SPEN 354 Materials Science for Space Engineering

Credits 3. 3 Lecture Hours. Study of the relationship between aerospace engineering material properties and microstructure; mechanical and thermal properties; environmental degradation; mechanical failure. **Prerequisites:** Grade of C or better in AERO 304.

SPEN 401 Space Design Principles

Credits 3. 3 Lecture Hours. Study of systems engineering; project lifecycle; stakeholder, concept of operations (CONOPS) and requirements definition; cost assessment; risk management; trade studies; decomposition and design of a space system; engineering ethics; technical communication. **Prerequisites:** Grade of C or better in AERO 307, SPEN 324, SPEN 354, and AERO 423.

SPEN 402 Space System Design

Credits 2. 2 Lecture Hours. Focuses on the design and analysis of a constellation of imaging satellites to develop 3D models of ground targets; emphasis on refinement of last semester's design and verification via the detailed simulation and optimization of the system's operations; project presented at the Engineering Project Showcase competition and the final capstone design review presentation. **Prerequisites:** Grade of C or better in AERO 307, SPEN 324, SPEN 354, AERO 423, and SPEN 401.

SPEN 437 Space Communications

Credits 3. 3 Lecture Hours. Basics of space communications systems; focuses on radio frequency communications systems and optical communications systems; topics include signals, modulations, source and channel coding, link performance, antennas and antenna arrays, transceivers, multiple access, communication networks, and advanced communications systems. **Prerequisites:** Grade of C or better in SPEN 201 and ECEN 314.

SPEN 439 Principles of Positioning, Navigation, and Timing

Credits 3. 3 Lecture Hours. Reference frames and transformations; Inertial Navigation Systems (INS) Global Navigation Satellite Systems (GNSS); timing sources and errors; applied Kalman filtering tools for GNSS/INS integration; image based navigation; spacecraft attitude sensors and algorithms; statistical signal processing methods for vehicle positioning system. **Prerequisites:** Grade of C or better in AERO 221, AERO 310, and AERO 423.

SPEN 441 Foundations of Space Autonomy

Credits 3. 3 Lecture Hours. Mathematical and computational foundations of aerospace systems autonomy; basic concepts to undertake the study of aerospace autonomous and intelligent systems (data structures, algorithms, probability theory, and optimization); classical artificial intelligence topics include search, constraint satisfaction, and logical and probabilistic reasoning; applications include planetary rovers and satellite swarms. **Prerequisites:** Grade of C or better in SPEN 401 or AERO 401, or concurrent enrollment.

SPEN 489 Special Topics in...

Credits 1 to 4. 1 to 4 Other Hours. Selected topics in an identified field of space engineering. May be repeated for credit. **Prerequisites:** Junior or senior classification, or approval of instructor.