Department of Aerospace Engineering

Aerospace engineers are concerned with the application of scientific principles and engineering concepts and practices to design, build, test and operate aerospace systems. The curriculum is intended to provide students with a broad understanding of fundamental scientific and technological principles, and to develop the ability to use these principles in developing solutions to engineering problems.

The objectives of the aerospace engineering program are: (1) to help students develop written and oral communication skills and to acquire a knowledge of history, literature and society; (2) to provide students a solid foundation in and a sound working knowledge of basic engineering principles; (3) to help students obtain an understanding of the engineering principles and skills specifically needed in the aeronautical and astronautical disciplines; and (4) to assist and encourage each student to develop an enhanced ability to learn and think creatively.

Required courses cover aeronautical and astronautical subjects. Students may also choose to emphasize either aeronautical or astronautical systems. Technical electives allow concentration in such areas as aerodynamics, astronautics, flight dynamics and control, propulsion, structures, and structural dynamics. The design of aerospace components and systems is considered to be an integral part of the education of aerospace engineers. Hence, design is included throughout the curriculum, beginning with a sophomore course in aerospace fundamentals and culminating in the senior design course sequence. Students are required to apply their theoretical knowledge of aerodynamics, dynamics, structures and propulsion to solve open-ended problems and to produce portions of preliminary designs.

Majors

- Aerospace Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofaerospaceengineering/aerospaceengineering_major/)

Courses

AERO 2200 AEROSPACE FUNDAMENTALS (2) LEC. 1. LAB. 3. Pr. (ENGR 1110 or ENGR 1113) and (PHYS 1600 or PHYS 1607). C or better in PHYS 1600. Introduction to the fundamental physical concepts required for the successful design of aircraft and spacecraft.

AERO 3110 AERODYNAMICS I (3) LEC. 3. Pr. MATH 2650 and AERO 2200. C or better in AERO 2200. Properties of fluids, fluid statics, conservation of mass and momentum, atmospheric properties, two dimensional airfoils, three dimensional wings, drag, and flight performance.

AERO 3120 AERODYNAMICS II (3) LEC. 3. Pr. ENGR 2010 and MATH 2650 and AERO 2200. C or better in AERO 2200. Principles of compressible flow including flows with area changes, friction and heat transfer. Fundamental analysis of aerodynamics and potential flow theory. Correlation of potential flow theory with experimental data.

AERO 3130 AERODYNAMICS LABORATORY (2) LEC. 1. LAB. 3. Pr. P/C AERO 2200. C or better in AERO 2200. Application of fundamental aerodynamic principles to subsonic and supersonic wind tunnel experiments.

AERO 3220 AEROSPACE SYSTEMS (3) LEC. 3. Pr. ENGR 2350 and MATH 2650. C or better in ENGR 2350. Modeling of system elements, classical feedback control techniques used in the analysis of linear systems, analysis of systems undergoing various motions connected with flight.

AERO 3230 FLIGHT DYNAMICS (4) LEC. 3. LAB. 3. Pr. AERO 3110 and ENGR 2350 and MATH 2650. C or better in ENGR 2350. Airplane performance and stability and control including analytical prediction of performance characteristics, experimental determination of static stability parameters, and analytical prediction of dynamic stability characteristics.

AERO 3310 ORBITAL MECHANICS (3) LEC. 3. Pr. ENGR 2350 and MATH 2650. C or better in ENGR 2350. Geometry of the solar system and orbital motion, mathematical integrals of motion, detailed analysis of two-body dynamics and introduction to artificial satellite orbits; Hohmann transfer and patched conics for lunar and interplanetary trajectories.

AERO 3610 AEROSPACE STRUCTURES I (2) LEC. 1. LAB. 3. Pr. ENGR 2070 or ENGR 2077. Fundamental concepts employed in the mechanical testing of engineering materials and structures. Load, stress, and strain measurement techniques are utilized to determine material properties and structural response.

AERO 3970 SPECIAL TOPICS (1-3) AAB. SU. Departmental approval. Investigation of various topics in Aerospace Engineering. Course may be repeated for a maximum of 6 credit hours.

AERO 4140 AERODYNAMICS III (3) LEC. 3. Pr. AERO 3110. Theoretical background essential to a fundamental understanding of laminar and turbulent boundary layers and their relations to skin friction and heat transfer.

AERO 4510 AEROSPACE PROPULSION (4) LEC. 3. LAB. 3. Pr. AERO 3120. Fundamental analysis of airbreathing jet propulsion. Introduction to chemical rocket propulsion.

AERO 4620 AEROSPACE STRUCTURES II (4) LEC. 3. LAB. 3. Pr. AERO 3610 and (MATH 2660 or MATH 2667). Aircraft and space vehicle structures. An introduction to the finite element method and its application to structural analysis. The laboratory will utilize state-of-the-art software numerical solution of aerospace structural systems.

AERO 4630 AEROSPACE STRUCTURAL DYNAMICS (4) LEC. 3. LAB. 3. Pr. AERO 4620. Free, forced and damped vibration of single and multiple degree-of-freedom systems. The laboratory will utilize state-of-the-art software for the analysis of the vibration and dynamic response of structural systems.

AERO 4710 AEROSPACE DESIGN I (3) LEC. 2. LAB. 3. Pr. AERO 3120. Introduction to the principles required to design aerospace vehicles.

AERO 4720 AEROSPACE DESIGN II (3) LEC. 2. LAB. 3. Pr. AERO 4710. This course is continuation of AERO 4710.

AERO 4730 SPACE MISSION DESIGN I (3) LEC. 2. LAB. 3. Pr. AERO 3120. And permission of the department. Introduction to the design of space systems including the identification of launch requirements, spacecraft system components, satellite tracking and orbital analysis to achieve a stated scientific objective.

AERO 4740 SPACE MISSION DESIGN II (3) LEC. 2. LAB. 3. Pr. AERO 4730. A continuation of AERO 4730, Space Mission Design I.

AERO 4970 SPECIAL TOPICS IN AEROSPACE ENGINEERING (1-3) AAB. Departmental approval. Investigation of current state-of-the-art technologies in aerospace engineering. Course may be repeated for a maximum of 9 credit hours.

AERO 4997 HONORS THESIS (1-3) IND. Pr. Honors College. Departmental approval. Membership in the Honors College and departmental approval required; Directed research and writing of an honors thesis. Course may be repeated for a maximum of 3 credit hours.

AERO 4AA0 PROGRAM ASSESSMENT (0) LAB. SU. Pr. P/C AERO 4710 or P/C AERO 4730. Academic program assessment covering the areas of aerodynamics, aerospace structures, orbital mechanics, propulsion and vehicle design.

AERO 5110 MISSILE AERODYNAMICS (3) LEC. 3. Pr. AERO 3120. Coreq. AERO 4140. Aerodynamics of slender wing-body combinations, interference effects, linear and non-linear effects, applications to missile design and performance.

AERO 5120 ROTARY WING AERODYNAMICS (3) LEC. 3. Pr. AERO 3110. Aerodynamics and flight characteristics of rotary-wing aircraft.

AERO 5140 COMPUTATIONAL FLUID DYNAMICS (3) LEC. 3. Pr. AERO 3110. An introduction to finite-difference and finite-volume methods for solving partial differential equations of interest in fluid dynamics.

AERO 5210 FLIGHT SIMULATION (3) LEC. 3. Pr. AERO 3230. Time domain simulation of nonlinear, six-degree-of-freedom motion of flight vehicles. Development of modular digital simulations including vehicle models for aerodynamics and propulsion, control, guidance subsystems.

AERO 5330 APPLIED ORBITAL MECHANICS (3) LEC. 3. Pr. AERO 3310. Introduction to general and special perturbations; N-body and restricted three-body problems; C-W equations, targeting and rendezvous; satellite constellations.

AERO 5410 AEROACOUSTICS (3) LEC. 3. Pr. AERO 3120 or Departmental approval. Fundamental concepts in acoustics: decibel scales, sound propagation and measurement, plane and spherical waves, room acoustics, transmission and reflection, reverberant fields and noise assessment. May count either AERO 5410 or AERO 6410.

AERO 5460 PERTURBATION METHODS (3) LEC. 3. Pr. MATH 2650. Analytical solutions of nonlinear problems, ODEs, PDEs, multiple scales, and transcendental equations in engineering, mathematics, and physics using both regular and singular perturbation methods. May count either AERO/MATH 5460 or AERO/MATH 6460.

AERO 5520 ROCKET PROPULSION (3) LEC. 3. Pr. AERO 4510. Analysis of the thermodynamics, gas dynamics and design of liquid and solid propellant rocket engines.

AERO 5530 SPACE PROPULSION (3) LEC. 3. Pr. AERO 4510. Analysis of space propulsion systems. Dynamics of electromagnetic systems, ion engines, photon drives, laser propulsion.

AERO 5630 AEROSPACE APPLICATIONS OF COMPOSITE MATERIALS (4) LEC. 3. LAB. 3. Pr. AERO 3610. Basic material and manufacturing information for laminated composite structures. Computational structural analysis of typical aerospace composite structures coupled with experimental verification of the structural response.

AERO 6110 MISSILE AERODYNAMICS (3) LEC. 3. Coreq. AERO 4140. Aerodynamics of slender wing-body combinations, interference effects, linear and non-linear effects, applications to missile design and performance.

AERO 6120 ROTARY WING AERODYNAMICS (3) LEC. 3. Aerodynamics and flight characteristics of rotary-wing aircraft.

AERO 6140 COMPUTATIONAL FLUID DYNAMICS (3) LEC. 3. An introduction to finite-difference and finite-volume methods for solving partial differential equations of interest in fluid dynamics.

AERO 6210 FLIGHT SIMULATION (3) LEC. 3. Time domain simulation of nonlinear, six-degree-of-freedom motion of flight vehicles. Development of modular digital simulations including vehicle models for aerodynamics and propulsion, control, guidance subsystems.

AERO 6330 APPLIED ORBITAL MECHANICS (3) LEC. 3. Special perturbation techniques: N-body perturbations; general and restricted three-body problems; preliminary orbit determination; C-W equations, targeting and rendezvous; constellation design; mission planning.

AERO 6410 AEROACOUSTICS (3) LEC. 3. Pr. AERO 4140 or Departmental approval. Fundamental concepts in acoustics: decibel scales, sound propagation and measurement, plane and spherical waves, room acoustics, transmission and reflection, reverberant fields and noise assessment. May count either AERO 5410/5413 or AERO 6410/6416.

AERO 6460 PERTURBATION METHODS (3) LEC. 3. Pr. MATH 2650. Departmental approval. Analytical solutions of nonlinear problems, ODES, PDEs, multiple scales, and transcendental equations in engineering, mathematics, and physics using both regular and singular perturbation methods. May count either AERO/MATH 5460 or AERO/MATH 6460.

AERO 6520 ROCKET PROPULSION (3) LEC. 3. Analysis of the thermodynamics, gas dynamics and design of liquid and solid propellant rocket engines.

AERO 6530 SPACE PROPULSION (3) LEC. 3. Pr. AERO 4510. Analysis of space propulsion systems. Dynamics of electromagnetic systems, ion engines, photon drives, laser propulsion.

AERO 6630 AEROSPACE APPLICATIONS OF COMPOSITE MATERIALS (4) LEC. 3. LAB. 3. Pr. AERO 3610. Basic material and manufacturing information for laminated composite structures. Computational structural analysis of typical aerospace composite structures coupled with experimental verification of the structural response.

AERO 6640 ADVANCED VISCOELASTICITY (3) DSL/LEC. An introduction to polymers and the theory of viscoelasticity. Topics include (1) a review of stress and strain analysis and measurement; (2) characteristics, applications, and properties of polymers; (3) polymerization and classification; (4) differential constitutive equations; (5) time and temperature behavior of polymers; (6) viscoelastic stress analysis; and (7) rate and time-dependent failure.

AERO 7100 ADVANCED SUPERSONIC AERODYNAMICS (3) LEC. 3. Pr. AERO 4140. A rigorous development of linearized and nonlinear fluid flow theories and application. Lifting surfaces, lifting bodies, duct flow, boundary layer effects, shock and expansion waves and method of characteristics.

AERO 7120 DYNAMICS OF VISCOUS FLUIDS I (3) LEC. 3. Pr. AERO 7100 or AERO 7106. Exact solutions to the Navier Stokes equations. Exact and approximate solutions of the laminar boundary layer equations. Incompressible and compressible boundary layers in theory and experiment.

AERO 7130 DYNAMICS OF VISCOUS FLUIDS II (3) LEC. 3. Pr. AERO 7120 or AERO 7126. Turbulent flows, the Reynolds stresses and turbulence modeling. Computation of incompressible and compressible turbulent boundary layers. Stability theory and transition.

AERO 7140 ADVANCED COMPUTATIONAL FLUID DYNAMICS (3) LEC. 3. Pr. AERO 5140 or AERO 6140. Advanced methods for solving problems in computational fluid dynamics. Topics include: discretization approaches, implicit solution techniques, curvilinear coordinate systems, and upwind schemes.

AERO 7150 COMPRESSIBLE FLUID DYNAMICS (3) LEC. 3. Pr. AERO 4140. Departmental approval. An introduction to the fundamental of compressible fluid dynamics. Application of conservation of mass, momentum and energy for compressible flows. May count either AERO 7150 or AERO 7156.

AERO 7160 PHYSICAL FOUNDATIONS OF TURBULENCE (3) LEC. 3. Pr. AERO 7120 or AERO 7126. Departmental approval. An introduction to turbulence using classical descriptions with a focus on the physics of turbulence phenomena. May count either AERO 7160 or AERO 7166.

AERO 7170 FUNDAMENTALS OF FLUIDS (3) LEC. 3. Introduction to principal concepts and methods of fluid dynamics; similarity and dimensional analysis; conservation of mass, momentum, and energy for flows in continuum; circulation and vorticity theorems; potential flow theory; introduction to some exact solutions based on simplifying assumptions for inviscid, viscous, unsteady, and compressible flow problems.

AERO 7200 DYNAMICS OF FLIGHT (3) LEC. 3. Departmental approval. Development of specialized concepts and methods in dynamics applicable to the modeling of flight vehicle motion. Stability concepts and analysis of the stability of flight vehicle motions. Effects of variable mass and flexibility.

AERO 7210 FLIGHT DYNAMICS OF HYPERVELOCITY VEHICLES (3) LEC. 3. Pr. AERO 7200 or AERO 7206. Departmental approval. Development of specialized concepts and methods in dynamics applicable to the modeling of hypersonic flight vehicle motion. Stability concepts and analysis of the stability of steady-state motions of very high speed flight vehicles.

AERO 7220 SPACECRAFT ATTITUDE DYNAMICS AND CONTROL (3) LEC. 3. Pr. AERO 7200 or AERO 7206. Development of specialized concepts and methods in dynamics applicable to the modeling of spacecraft rotational motion. Methods for controlling spacecraft attitude. Analysis of the attitude stability and controllability of spacecraft attitude motion. Department approval.

AERO 7330 ORBIT DETERMINATION (3) LEC. 3. Pr. AERO 6330 or AERO 6336 or AERO 6230 or AERO 6236. Elements of orbit determination; least squares, minimum norm, minimum variance solutions; batch, sequential and extended sequential filters.

AERO 7340 ADVANCED ORBITAL MECHANICS (3) LEC. 3. Pr. AERO 6330 or AERO 6336 or AERO 6230 or AERO 6236. Elements of time measurements, earth orientation/coordinate system; f and g series; Lambert's Problem; linear orbit theory and circumlunar trajectories.

AERO 7350 OPTIMAL CONTROL OF AEROSPACE VEHICLES (3) LEC. 3. Principles of optimization; Pontryagin's principle; Linear quadratic regulator; Observers, state estimation, LQG problem. Optimal output feedback; Synthesis of flight control systems. AERO 3220 or equivalent.

AERO 7360 ADVANCED TRAJECTORY OPTIMIZATION (3) LEC. 3. Departmental approval. This course reviews single- and multi-variable optimization techniques of deterministic continuous systems. A review of the necessary (KKT) and sufficient conditions for optimality is given. We will review principles of dynamic programming and the Hamilton-Jacobi-Bellman (HJB) equation. We will also review Linear Programming (LP) problems and Quadratic Programming (QP) problems. Application of the QP problems for minimum-snap trajectory optimization for path planning of quad-rotors is demonstrated. We will also introduce basic concepts of convex optimization, which uses many of the concepts introduced in the LP and QP problems. The final project is to solve a trajectory optimization problem using successive linearization, which is a widely used technique for converting non-convex problems to convex ones.

AERO 7410 LIGHT-FIELD IMAGING (3) LEC. 3. Pr. AERO 7160 or AERO 7166. Departmental approval. An introduction to light-field imaging. Topics include light parameterization, light field cameras, computational photography and Fourier slice photography theorem. May count either AERO 7410 or AERO 7416.

AERO 7420 PARTICE IMAGE VELOCIMETRY (3) LEC. 3. Pr. AERO 7120 or AERO 7126. Departmental approval. An introduction to particle image velocimetry and it variations including conventional planar PIV, stereo PIV, stereo-PIV and torno-PIV. May count either AERO 7420 or AERO 7426.

AERO 7450 AEROSPACE ENGINEERING ANALYSIS (3) LEC. 3. Analysis and techniques for solving ordinary and partial differential equations common in Aerospace applications.

AERO 7460 ADVANCED PERTURBATION METHODS (3) LEC. 3. Departmental approval. Solutions of nonlinear problems and integrals using WKB, Rayleigh-Janzen, Generalized Scales, Latta, van der Pol, Watson, Laplace, Adomian, homotopy, Pade, Liouville-Green and Burmann transformations. May count either AERO 7460/7466 or MATH 7460/7466.

AERO 7510 THRUST GENERATION (3) LEC. 3. Pr. AERO 4510. Aerothermodynamics of propulsion. Selected topics in gas dynamics, thermodynamics, and heat transfer as applied to airbreathing and space propulsion.

AERO 7520 ADVANCED AIR-BREATHING PROPULSION (3) LEC. 3. Topics emphasizing interaction between external aerodynamics and performance of airbreathing jet engines. Performance optimization of ramjet, turbojet, and turbofan engines. Component matching.

AERO 7530 AEROTHERMCHEM OF PROPULSION (3) LEC. 3. Aerothermodynamics of compressible flow, chemical propellant characteristics, heat transfer in fluid flow, statistical gas dynamics, kinetic theory of gases.

AERO 7600 AEROSPACE SOLID MECHANICS (3) LEC. 3. An introduction to solid mechanics concepts with aerospace engineering applications. The course develops equations of motions from conservation laws and introduces constitutive equations from linearized continuum mechanics perspective for aerospace related applications. Topics include elastostatic solutions, elastodynamic solutions and plasticity.

AERO 7620 AEROSPACE COMPUTATIONAL STRUCTURAL ANALYSIS: STATIC STRUCTURES (3) LEC. 3. Pr. AERO 4620. Departmental approval. Advanced techniques for the numerical solution of static elastic and plastic problems, including two and three dimensional solutions.

AERO 7630 AEROSPACE COMPUTATIONAL STRUCTURAL ANALYSIS: STRUCTURAL DYNAMICS (3) LEC. 3. Pr. AERO 4630. Departmental approval. Advanced techniques for the numerical solution to problems in structural dynamics, including steady state and transient response of two-and three-dimensional structures.

AERO 7950 SEMINAR (0) SEM. 0. SU. Weekly lectures on current developments in aerospace sciences by staff members, graduate students, and visiting scientists and engineers. Course may be repeated for a maximum of 1 credit hours.

AERO 7970 SPECIAL TOPICS IN AEROSPACE ENGINEERING (1-3) DSL. Course may be repeated for a maximum of 9 credit hours.

AERO 7980 AEROSPACE ENGINEERING PROJECT (3) LEC. 3. SU. Departmental approval. Intended for students in the MAE program. On or off-campus project. The nature of the project is to be determined by the student's major professor. Approval of the project and its final written report by the student's advisory committee is required. Course may be repeated with change in topic.

AERO 7990 RESEARCH AND THESIS (1-10) DSL/MST. Credit hours to be arranged. Course may be repeated with change in topics.

AERO 8990 RESEARCH AND DISSERTATION (1-10) DSL/DSR. Individual doctoral dissertation research. May be repeated for credit. Course may be repeated with change in topics.