AEROSPACE ENGINEERING (AENG)

AENG 1001 - Introduction to Aerospace & Mechanical Engineering
Credit(s): 1 Credit
This course will introduce aerospace and mechanical engineering. Through hands-on activities, students will learn the basics of engineering design and entrepreneurship. Working in teams, students will build aerospace and mechanical systems, practice entrepreneurial thinking, and develop the personal and professional skills needed to engage in lifelong learning. This course is open to non-majors.

AENG 1002 - Computer-Aided Engineering Design
Credit(s): 1 Credit
This course is an introduction to engineering drawing and computer aided design (CAD) and 3D solid modeling. Students will learn to interpret engineering drawings, create engineering drawings, and create 3D models of mechanical systems.

AENG 2000 - Intro to Aeronautics & Astron
Credit(s): 3 Credits
The nature of aerodynamic forces; incompressible and compressible fluid flow; lift and drag; introduction to performance, stability and control; propulsion; structures; rocket performance and orbits. The design process.
Prerequisite(s): ((AENG 1002*, MENG 1002*, or ESCI 1020*))
* Concurrent enrollment allowed.

AENG 2910 - Co-op with Industry
Credit(s): 0 Credits (Repeatable for credit)
A full-time supervised work experience with an agency, firm or organization that employs persons in this degree field. This course is used for the first experiential learning session. Grading system is determined by department offering course. (Offered every Fall, Spring and Summer)
Restrictions:
Students with a semester level of Freshman may **not** enroll.

AENG 2930 - Special Topics
Credit(s): 3 Credits (Repeatable for credit)

AENG 2980 - Independent Study
Credit(s): 1 or 3 Credits (Repeatable for credit)

AENG 3000 - Performance
Credit(s): 3 Credits
Aircraft performance characteristics, level flight, rate-of-climb, range and endurance, take-off and landing, turn performance, energy state approximation, propeller theory and analysis, constraint analysis, carpet plots and design methodology.
Prerequisite(s): AENG 2000

AENG 3100 - Computer Aided Engineering
Credit(s): 3 Credits
The course outlines the principles of Computer Aided Engineering. The computer applications to structural design, kinematic synthesis and design optimization are explored.
Prerequisite(s): CSCI 1060; ESCI 3100

AENG 3150 - Astrodynamics
Credit(s): 3 Credits
Space environment; two-body problem and introduction to orbit mechanics; rigid body dynamics; satellite dynamics, rocket performance; re-entry dynamics. (Offered every Spring)
Prerequisite(s): AENG 2000; ESCI 2150

AENG 3210 - Gas Dynamics
Credit(s): 3 Credits
One-dimensional gas dynamics; normal and oblique shock waves; Prandtl-Meyer flows; Rayleigh and Fanno-line flow; method of characteristics. (Offered every Spring)
Prerequisite(s): ESCI 2300; ESCI 3200; MATH 3270*
* Concurrent enrollment allowed.

AENG 3220 - Aerodynamics
Credit(s): 3 Credits
Circulation and vorticity; irrotational flows and potential flow theory; Kutta-Joukowski theorem, subsonic thin airfoil and finite wing theory; subsonic compressible flow; supersonic thin airfoil theory; slender body theory, Newtonian impact theory. (Offered every Spring)
Prerequisite(s): ESCI 3200 and MATH 3270*
* Concurrent enrollment allowed.

AENG 3910 - Co-op with Industry
Credit(s): 0 Credits (Repeatable for credit)
A full-time supervised work experience with an agency, firm or organization that employs persons in this degree field. This course is used for the second experiential learning session. Grading system is determined by department offering course. (Offered every Fall, Spring and Summer)
Prerequisite(s): AENG 2910

AENG 3915 - Internship with Industry
Credit(s): 0-3 Credits (Repeatable for credit)
A work experience with an agency, firm or organization that employs persons in this degree field. This experience may be full time or part-time as required by the industry sponsor. This course is used for the first experiential learning session. Grading system is determined by department offering course. (Offered every Fall, Spring and Summer)
Restrictions:
Enrollment limited to students with a semester level of Junior or Senior.

AENG 3930 - Special Topics
Credit(s): 3 Credits (Repeatable for credit)

AENG 3980 - Independent Study
Credit(s): 1 or 3 Credits (Repeatable for credit)

AENG 4004 - Flight Vehicle Analysis and Design I
Credit(s): 3 Credits
Application of aerospace engineering to the design methodology of a flight vehicle. (Offered every Fall)
Prerequisite(s): AENG 3000 and AENG 4400*
* Concurrent enrollment allowed.

AENG 4014 - Flight Vehicle Analysis and Design II
Credit(s): 3 Credits
Application of aerospace engineering to the detail design of a flight vehicle, model design, fabrication testing, evaluation and analysis. (Offered every Spring)
Prerequisite(s): AENG 4004

AENG 4050 - Space Mission Analysis and Design
Credit(s): 3 Credits (Repeatable for credit)
Selected topics of special interest to aerospace engineering majors.

AENG 4110 - Flight Vehicle Structures
Credit(s): 3 Credits
Introduction to theory of elasticity; behavior of materials including composites; torsional and bending shear flows in thin walled structures; shear center; analysis of semi-monocoque structures; joints and fittings; elastic and inelastic buckling; and fatigue analysis. Application of FEM methods.
Prerequisite(s): AENG 3100[*]
[*] Concurrent enrollment allowed.

AENG 4111 - Aerospace Laboratory
Credit(s): 1 Credit
Experimental studies in subsonic and supersonic air flows. Measurements of strains and deflections in aerospace structures under simulated loading conditions; static and dynamic measurements. Design of experiments, collection, reduction, evaluation and comparison of data. (Offered every Fall)
Prerequisite(s): AENG 3000; AENG 4110[*]
[*] Concurrent enrollment allowed.

AENG 4140 - Hypersonics
Credit(s): 3 Credits
Introduction to hypersonics. Newtonian and Busemann Theory; slender body theory; shock expansion theory; small disturbance theory and supersonic similitude; blast wave theory. Thin shock layer theory.
Prerequisite(s): AENG 3210

AENG 4150 - Orbital Mechanics
Credit(s): 3 Credits
Orbital dynamics of space vehicles with emphasis on engineering design and application to specific mission analysis. Orbit determination and maneuvers; interplanetary transfer and trajectory optimization; proximity operations; perturbation effects.
Prerequisite(s): AENG 3150

AENG 4210 - Propulsion
Credit(s): 3 Credits
Ramjet, turbojet, turbofan and turboshaft cycle analysis; component analysis and matching; turbojet off-design performance. Aircraft/engine integration. (Offered every Fall)
Prerequisite(s): AENG 3210

AENG 4230 - Intro to Comp. Fluid Dynamics
Credit(s): 3 Credits
This course is designed to establish the fundamentals of computational fluid dynamic schemes and methods to solve the PDEs. The students will learn how various schemes are applied to proposed to model equations, and analyze the resulting solutions.
Prerequisite(s): ESCI 3200

AENG 4240 - Helicopter Theory and Performance
Credit(s): 3 Credits
Airfoil theory as applied to propellers and rotors. Momentum and blade element theories, rotor dynamics during climb, hover, descent and autorotation; preliminary design techniques and rotor blade dynamics.
Prerequisite(s): AENG 3000

AENG 4400 - Stability and Control
Credit(s): 3 Credits
Static stability and aircraft control; equations of motion, dynamic stability; closed loop control. (Offered every Fall)
Prerequisite(s): AENG 3000 and ESCI 3410[*]
[*] Concurrent enrollment allowed.

AENG 4410 - Flight Simulation
Credit(s): 3 Credits
Overview of various types of simulators; introduction to major software and hardware components of state-of-the-art simulators; development of computer models of aircraft systems and performance characteristics and interfacing the models with each other to achieve high-fidelity, real time aircraft simulation. Use of reconfigurable flight simulator, whenever possible.
Prerequisite(s): AENG 4400

AENG 4530 - Composite Structures & Design
Credit(s): 3 Credits
Fiber and resin systems. Composite material properties and characterization; laminae. laminates, macro and micro-mechanics. Analysis and design of lamina and laminate.
Prerequisite(s): MATH 3270; MENG 3100

AENG 4700 - Aeroelasticity
Credit(s): 3 Credits
Aerodynamic loads on a flexible surface. General formulation of aeroelastic problems. Control effectiveness and reversal. Wing divergence. Two - and three dimensional flutter theory. Empennage vibration and flutter analysis. Flutter prevention. Testing techniques.
Prerequisite(s): AENG 4110; ESCI 3110

AENG 4800 - Systems Engineering
Credit(s): 3 Credits (Repeatable for credit)
Selected topics of special interest to aerospace engineering majors.

AENG 4910 - Co-op with Industry
Credit(s): 0 Credits (Repeatable for credit)
A full-time supervised work experience with an agency, firm or organization that employs persons in this degree field. This course is used for the third experiential learning session. Grading system is determined by department offering course. (Offered every Fall, Spring and Summer)
Prerequisite(s): AENG 3910

AENG 4915 - Internship with Industry
Credit(s): 0-3 Credits (Repeatable for credit)
A work experience with an agency, firm or organization that employs persons in this degree field. This experience may be full time or part-time as required by the industry sponsor. Grading system is determined by department offering course. (Offered every Fall, Spring and Summer)

AENG 4930 - Special Topics in Aerospace Engineering
Credit(s): 3 Credits (Repeatable for credit)
Selected topics of special interest to aerospace engineering majors.

AENG 4980 - Independent Study
Credit(s): 1-3 Credits (Repeatable for credit)
Credit to be arranged. Independent study on an aerospace engineering topic under the direction of a faculty member.

AENG 5009 - Seminars
Credit(s): 0 Credits (Repeatable for credit)
Presentations of current research by students, faculty, and guests. Registration required in the first semester. Seminar attendance expected in subsequent semesters.

AENG 5050 - Space Mission Analysis and Design
Credit(s): 3 Credits
Basic spacecraft types and their applications. Major subsystems of a spacecraft system. Space environment, propulsion system, power system, structural design, spacecraft dynamics and attitude control, orbit mechanics, thermal control, communications, and ground segments, command and data handling. Spacecraft integration and testing.

AENG 5060 - Advanced Space Mission Design
Credit(s): 3 Credits
Working in teams, students will perform a complete 'Phase A' study of a proposed space mission, culminating in an overall system description, preliminary design and subsystem-level requirements, as well as a feasibility study for developing this mission at St Louis University. The proposed mission will relate to near-term research interests of the instructor and other faculty with the intent of developing a real spacecraft. Students will be responsible for developing requirements and performing trade studies, preliminary sizing and mission analysis for all necessary subsystems (structures, power, thermal control, communications, command & data handling, attitude control, and/or navigation). Where possible, hardware prototypes and simulations will be created. Students will learn through lecture, individual research, and team projects.
Prerequisite(s): AENG 5050

AENG 5150 - Orbital Mechanics
Credit(s): 3 Credits
Orbital dynamics of space vehicles with emphasis on engineering design and application to specific mission analysis; orbit determination and maneuvers; interplanetary transfer and trajectory optimization; proximity operations; perturbation effects.
Prerequisite(s): AENG 3150

AENG 5230 - Introduction to Computational Fluid Dynamics
Credit(s): 3 Credits
This course is designed to establish the fundamentals of computational fluid dynamic schemes and methods to solve the governing PDEs. The students will learn how various schemes are applied to proposed model equations, and analyze the resulting solutions.
Prerequisite(s): ESCI 3200

AENG 5240 - Hypersonics
Credit(s): 3 Credits
This course covers the history of hypersonic efforts; characteristics of hypersonic flow; slender body theory; hypersonic similitude; viscous interactions; transition to turbulence; high-temperature gas dynamics; thermal protection systems; and hypersonic propulsion systems.
Prerequisite(s): AENG 502; MATH 5102

AENG 5260 - Unsteady Aerodynamics of Bluff Bodies
Credit(s): 3 Credits
This course is an introduction to the aerodynamics of non-streamlined (i.e. bluff) bodies in both the steady and unsteady regimes. Topics include: aerodynamics of bodies in accelerated motion vs. steady motions; structure of the near and far wakes behind flat plates (in normal flows). Several examples shall be discussed in depth as well, encompassing examples from both engineering and natural worlds: 1) blimp flight and the role of apparent mass; 2) parachute under descent; 3) inflating parachutes; 4) spacecraft drag during atmospheric re-entry; 5) wake re-contact during decelerating motion 6) wave-generated drag on ocean piles; 7) engulfment drag by whales; 8) fast start by shrimp.
Prerequisite(s): MATH 5102

AENG 5280 - Applied Aerodynamics
Credit(s): 3 Credits
This course introduces students to analytical and numerical methods applicable to airfoils and wings. Student will be able to model two- and three-dimensional flows. Student will understand how to estimate lift and drag of wings using analytically and numerically methods. Students will have an understanding of high-lift systems and of rotor aerodynamics.

AENG 5400 - Guidance, navigation and Estimation for Dynamic Vehicles
Credit(s): 3 Credits
This course covers three aspects of advanced control of dynamic vehicles. The Estimation module is concerned with topics in automatic control theory related to the modeling of a vehicle state: observability, noise and uncertainty, filtering theory (Weiner Filters, Standard and Extended Kalman Filtering), and simulation. The Guidance module complements Estimation with respect to control: controllability, linear quadratic regulation, as well as a review of rotational dynamics and orbital mechanics. The Navigation module covers real-world examples of sensors and actuators, including inertial systems and GPS, with an emphasis again on noise and uncertainty. Students will develop complete dynamic simulations of real vehicles, including state estimation and control.

AENG 5410 - Flight Simulation
Credit(s): 3 Credits
Overview of various types of simulators; introduction to major software and hardware components of state-of-the-art simulators; development of computer models of aircraft systems and performance characteristics and interfacing the models with each other to achieve high-fidelity, real time aircraft simulation. Field trips to area flight simulation facilities. Use of, and projects in, reconfigurable flight simulator.

AENG 5450 - Space Dynamics & Control
Credit(s): 3 Credits
Motion in moving reference frames; Eulers equations; attitude dynamics; motion of a rigid spacecraft; attitude control systems and maneuvers; spacecraft and attitude feedback control; attitude determination and attitude control.
Prerequisite(s): MATH 5102

AENG 5460 - Modern Control Systems
Credit(s): 3 Credits
Introduction to system theory, state variables and state space description to dynamic systems, linear vector space and dependence. Jordan canonical forms, Cayley-Hamilton theorem, system stability, controllability and observability, relation between state-space and transfer function models. A brief introduction to Nonlinear systems, Lyapunov stability theory will be provided. This course will give the basic knowledge for more advanced control courses, such as nonlinear control, robust control, optimal control, adaptive control.

AENG 5470 - Advanced Control Systems
Credit(s): 3 Credits
Introduction to nonlinear systems. Differences between linear and nonlinear systems. Mathematical preliminaries. Equilibrium points of nonlinear systems. Phase plane analysis and limit cycles. Stability definitions for nonlinear systems. Lyapunov's indirect and direct methods. Stability of autonomous and non-autonomous systems. Describing function analysis. Brief introductions to modules on nonlinear control design including adaptive and nonlinear robust control. Applications of nonlinear control design.
Prerequisite(s): AENG 5460

AENG 5530 - Composite Materials for Structure and Design
Credit(s): 3 Credits
Fiber and resin systems, Composite material properties and characterization, lamina, Laminate, Micro-mechanics, Stress analysis of lamina and laminate, Design of laminate, Failure theories, and Manufacturing of laminate.
Prerequisite(s): AENG 4230

AENG 5700 - Aeroelasticity
Credit(s): 3 Credits
This course presents the fundamentals of Aeroelasticity involved with divergence, flutter and control surface reversal of primary lifting surfaces and empennage on aircraft and missiles. Beam vibration, aeroelastic equations and their solutions, unsteady aerodynamics, quasi-steady aerodynamics and finite state aerodynamics..

AENG 5750 - Parachute Systems and Design
Credit(s): 3 Credits
This course is an introduction to the various applications, aerodynamics and design rules of parachute systems. It is intended for engineering graduate students and professional engineers. The topics include: review of current use in aviation and space; parachute configurations and components; parachute testing techniques and facilities; parachute aerodynamics and flight dynamics; parachute inflation; gliding parachutes; non-terrestrial applications; parachute system design.

AENG 5800 - Autonomous Systems Design
Credit(s): 3 Credits
This course introduces students to the design of autonomous systems. Student will demonstrate the ability to evaluate a system and develop a correct mathematical model of its dynamics. Student will understand the fundamentals of autonomous operation and the required integration of the various sub-systems.

AENG 5850 - Space Mission Failures
Credit(s): 3 Credits
Space systems are designed to operate in the presence of multiple failures. And yet, occasionally, systems will still fail spectacularly. Reasons for failure include operator error, incorrect design, and manufacturing defects. The odds of these failures occurring can be significantly reduced through good systems engineering practice. But, in some cases, the very systems engineering practices themselves directly contribute to the failure. This course will introduce the fundamentals of good systems engineering practice. A series of case studies in failures (rockets, spacecraft, rovers, etc.) will be used to illustrate these principles and the new vulnerabilities they introduce.

AENG 5910 - Co-op with Industry
Credit(s): 1-6 Credits
A full-time supervised work experience with an agency, firm or organization that employs persons in this degree field. This course is used for experiential learning session. Grading system is determined by department offering course. Offered every semester. 0-3 credit hours. DEPARTMENT PERMISSION NEEDED FOR ENROLLMENT.

AENG 5915 - Internship with Industry
Credit(s): 1-3 Credits
A work experience with an agency, firm or organization that employs persons in this degree field. This experience may be full time or part-time as required by the industry sponsor. Grading system is determined by department offering the course. Offered every semester. 0-3 credit hours.

AENG 5930 - Special Topics
Credit(s): 1-3 Credits (Repeatable for credit)
A one-time course on a particular topic, or a trial course that is expected to become a standard course with its own unique course number.

AENG 5964 - Masters Project
Credit(s): 1-3 Credits
Theoretical/computational/experimental work that leads to a Project Report and defense of the Project.

AENG 5974 - Research Topics
Credit(s): 1-3 Credits

AENG 5980 - Independent Study
Credit(s): 1 or 3 Credits (Repeatable for credit)

AENG 5984 - Independent Study
Credit(s): 1-3 Credits (Repeatable for credit)
A non-classroom course in which a student explores a topic that is related to the student's graduate work and career goals.

AENG 5994 - Masters Thesis Research
Credit(s): 0-6 Credits (Repeatable for credit)
Research that leads to a Masters Thesis and final defense of the Thesis.

AENG 6910 - Co-op with Industry
Credit(s): 1-6 Credits
A full-time supervised work experience with an agency, firm or organization that employs persons in this degree field. This course is used for experiential learning session. Grading system is determined by department offering the course. Offered every semester. 0-3 credit hours. DEPARTMENT PERMISSION NEEDED FOR ENROLLMENT.

AENG 6915 - Internship with Industry
Credit(s): 1-3 Credits
A work experience with an agency, firm or organization that employs persons in this degree field. This experience may be full time or part-time as required by the industry sponsor. Grading system is determined by department offering the course. Offered every semester. 0-3 credit hours. DEPARTMENT PERMISSION NEEDED FOR ENROLLMENT.

AENG 6930 - Special Topics
Credit(s): 3 Credits (Repeatable for credit)

AENG 6974 - Research Topics
Credit(s): 1-3 Credits
Theoretical or Computational or experimental work that is not part of the Dissertation.

AENG 6980 - Independent Study
Credit(s): 1 or 3 Credits (Repeatable for credit)

AENG 6984 - Independent Study
Credit(s): 1-3 Credits (Repeatable for credit)
A non-classroom course in which a student explores a topic that is related to the student's doctoral work and career goals.

AENG 6994 - Doctoral Dissertation Research
Credit(s): 0-6 Credits (Repeatable for credit)
A non-classroom course in which a student explores a topic that is related to the student's doctoral work and career goals.