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.  
Restrictions: Students in the Madrid, Spain campus may not enroll.

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.  
Restrictions: Students in the Madrid, Spain campus may not enroll.

AENG 2000 - Intro to Aeronautics & Astronautics  
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*); PHYS 1610*)  
* Concurrent enrollment allowed.

AENG 2020 - Introduction to Aerospace Engineering  
Credit(s): 1 Credit  
An introduction to the aerospace profession and aerospace design, including aerospace history, aircraft and rocket performance, stability and control, propulsion, and structures, with an emphasis on design projects.  
(Offered in Fall)  
Prerequisite(s): Minimum Earned Credits of 30

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 classification of Freshman may not enroll.

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 or AENG 2020)

AENG 3050 - Design of Space Missions  
Credit(s): 3 Credits  
Prerequisite(s): AENG 3150*  
* Concurrent enrollment allowed.

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  
Restrictions: Students in the Madrid, Spain campus may not enroll.

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 or AENG 2020)  
Restrictions: Students in the Madrid, Spain campus may not enroll.

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 3230 - Advanced Aerodynamics  
Credit(s): 3 Credits  
Recent developments in aerodynamics and physical fluid dynamics.  
(Offered every Fall)  
Restrictions: Students in the Madrid, Spain campus may not enroll.

AENG 3350 - Introduction to Thermodynamics  
Credit(s): 3 Credits  
The first and second laws of thermodynamics; application to ideal gases; cyclic processes; application to steam and gas turbines.  
(Offered every Fall)  
Prerequisite(s): PHYS 2200, PHYS 2210  
Restrictions: Students in the Madrid, Spain campus may not enroll.

AENG 3410 - Propulsion  
Credit(s): 3 Credits  
Thermochemical engines; rocket performance; rocket propulsion devices.  
(Offered every Spring)  
Prerequisite(s): AENG 3150*  
* 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
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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 classification of Junior or Senior.
Students in the Madrid, Spain campus may not enroll.

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.
Restrictions:
Students in the Madrid, Spain campus may not enroll.

AENG 4010 - 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.
Restrictions:
Students in the Madrid, Spain campus may not enroll.

AENG 4011 - 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.
Restrictions:
Students in the Madrid, Spain campus may not enroll.

AENG 4110 - 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
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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.
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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
Restrictions:
Students in the Madrid, Spain campus may not enroll.
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.
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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
Restrictions:
Students in the Madrid, Spain campus may not enroll.

AENG 4700 - Aeroelasticity
Credit(s): 3 Credits
Prerequisite(s): AENG 4110, ESCI 3110
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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)
Restrictions:
Students in the Madrid, Spain campus may not enroll.

AENG 4930 - Special Topics in Aerospace Engineering
Credit(s): 3 Credits (Repeatable for credit)
Selected topics of special interest to aerospace engineering majors.
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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 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.
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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
Restrictions:
Students in the Madrid, Spain campus may not enroll.

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. Students 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.  
Restrictions:  
Students in the Madrid, Spain campus may not enroll.

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.  
Restrictions:  
Students in the Madrid, Spain campus may not enroll.

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.  
Restrictions:  
Students in the Madrid, Spain campus may not enroll.

AENG 5470 - Advanced Control Systems  
Credit(s): 3 Credits  
Prerequisite(s): AENG 5460

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.  
Restrictions:  
Students in the Madrid, Spain campus may not enroll.

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.  
Restrictions:  
Students in the Madrid, Spain campus may not enroll.

AENG 5945 - Masters Project  
Credit(s): 1-3 Credits  
Theoretical/computational/experimental work that leads to a Project Report and defense of the Project.  
Restrictions:  
Students in the Madrid, Spain campus may not enroll.

AENG 5946 - Independent Study  
Credit(s): 1 or 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.  
Restrictions:  
Students in the Madrid, Spain campus may not enroll.

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.  
Restrictions:  
Students in the Madrid, Spain campus may not enroll.