AEROSPACE ENGINEERING (AERO)

AERO Courses

AERO 121. Aerospace Fundamentals. 2 units
Introduction to the engineering profession including the aeronautical and aerospace fields. Engineering approach to problem-solving and analysis of data obtained from experiments. Basic nomenclature and design criteria used in the aerospace industry. Applications to basic problems in the field. 1 lecture, 1 laboratory.

AERO 200. Special Problems for Undergraduates. 1-4 units
Prerequisite: Consent of department head.
Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units.

AERO 215. Introduction to Aerospace Design. 2 units
Prerequisite: AERO 121, MATH 143, and IME 144. Recommended: CSC 111.
Introduction to problem solving techniques and team-centered design projects in aerospace engineering. Primary emphasis on the solutions of design problems in aerospace engineering using computers. 2 laboratories.

AERO 220. Aerospace Systems Engineering and Integration. 1 unit
Prerequisite: AERO 121.
Project-based study of fundamental systems engineering concepts including sub-system interface requirements, verification and validation, modeling/analysis/design, and implementation of complex aerospace systems. 1 laboratory.

AERO 270. Selected Topics. 1-4 units
Prerequisite: Open to undergraduate students and consent of instructor.
Directed group study of selected topics. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

AERO 299. Aerodynamics. 4 units
Prerequisite: AERO 121, MATH 244, ME 211, and PHYS 133.
Basics of thermodynamics, energy, systems and control volume analysis. First law; second law, phase change and energy analysis for aerospace-relevant applications. Entropy and exergy, cycle analysis (Rankine, Brayton, turbojets and turbofans). Not open to students with credit in AERO 301. 3 lectures, 1 laboratory.

AERO 300. Aerospace Engineering Analysis. 5 units
Prerequisite: AERO 215, MATH 244, ME 211, and PHYS 133.
Analytical and numerical methods for aerospace engineering problems. Topics include vector calculus, linear algebra, ordinary and partial differential equations, and Fourier transforms. Computer tools and numerical methods as applied to problems in aerodynamics, structures, stability and control and astronautics. 4 lectures, 1 laboratory.

AERO 302. Aerospace Fluid Mechanics. 4 units
Prerequisite: ME 212. Corequisite: AERO 300. Recommended: AERO 215; and AERO 299 or AERO 301.
Properties of fluids, statics, mass/energy/momentum for aeronautical applications, external aerodynamics (lift and drag), dimensional analysis for scale testing, introduction to differential analysis and Navier-Stokes equations, basics of laminar and turbulent boundary layers. 3 lectures, 1 laboratory.

AERO 303. Aerospace Gas Dynamics and Heat Transfer. 4 units
Prerequisite: AERO 299 or AERO 301; and AERO 302.
Basics of heat transfer and approaches to problem solving, steady heat conduction, convection (forced and natural), heat exchanger design, shock waves and compressible flow in nozzles and diffusers (normal, oblique, expansion waves), thermal radiation and applications. 3 lectures, 1 laboratory.

AERO 306. Aerodynamics and Flight Performance. 4 units
Prerequisite: AERO 215; AERO 299 or AERO 301. Concurrent: AERO 302.
Introduction to theoretical aerodynamics. Primary emphasis in the subsonic region, including compressibility effects. Basic aerodynamic theory: Airfoil theory, wing theory, lift and drag. Team-centered aerodynamic design. Flight performance. 4 lectures.

AERO 307. Experimental Aerodynamics. 2 units
Prerequisite: AERO 302, AERO 306, ENGL 149.
Wind tunnel testing of basic aerodynamic properties of airfoils, finite wings, aircraft or spacecraft models, and vehicle flight performance. Emphasis on both static and dynamic responses of aircraft. Various measurement techniques, data reduction schemes, and analysis methods. 2 laboratories.

AERO 310. Air and Space. 4 units
2020-21 or later: Upper-Div GE Area B
2019-20 catalog: GE Area B7
2017-19 or earlier catalog: GE Area F
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; and completion of GE Areas B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs).
Technological innovations that have led to modern aircraft and spacecraft as viewed from an historical perspective. Development of aerodynamics, propulsion systems, light-weight structures, and control systems. How aviation has affected, and been affected by, history. Impact of aviation on society, including civil and military aircraft/spacecraft. Federal regulation of aviation, including air traffic control and airlines. Future developments in air and space technology. 4 lectures. Crosslisted as AERO/HNRS 310. Fulfills GE Upper-Division B (GE Area B7 for students on the 2019-20 catalog; GE Area F for students on earlier catalogs).

AERO 320. Fundamentals of Dynamics and Control. 4 units
Prerequisite: AERO 300 and ME 212. Corequisite: AERO 321.
Introduction to six degree of freedom rigid body dynamic and kinematic equations of motion, including coordinate transformations, Euler angles and quaternions for aerospace vehicles. Linearization and dynamic system theory and stability. Introduction to linear control theory, controller design and analysis. 4 lectures.
AERO 321. Experimental Sensors, Actuators and Control. 1 unit
Corequisite: AERO 320.
Experiments in translational and rotational dynamics, structural, thermal, and flow control. Comparison of modeling/simulation results to experimental data. Role of actuators, sensors, noise, feedback, and supporting instrumentation hardware and software. Introduction to technical communication. 1 laboratory.

AERO 331. Aerospace Structural Analysis I. 4 units
Prerequisite: AERO 300, CE 207 or CE 208, and ME 212.

AERO 350. Fundamentals of Systems Engineering. 2 units
Prerequisite: AERO 220.
Systems engineering principles and methods applied to the design of aerospace systems. System-level requirements, user needs and stakeholder constraints, component-level requirements, and requirements breakdown structure. Project planning and tracking. Trade studies for design decision making. 2 lectures.

AERO 351. Introduction to Orbital Mechanics. 4 units
Prerequisite: AERO 300 and ME 212.
Motion of a body in a central field. Keplerian Orbits. Orbital maneuvers. Interplanetary trajectories. 4 lectures.

AERO 354. Space Environment Laboratory. 2 units
Prerequisite: AERO 353 or AERO 355; and ENGL 149.
Laboratory examples of the effects of the space environment on a spacecraft and design considerations. Topics include the launch, vacuum, particulate, plasma, and radiation environments. All topics are applied to how the environment affects spacecraft design considerations. Not open to students with credit in AERO 356. 2 laboratories.

AERO 355. Space Environments I. 3 units
Prerequisite: AERO 300.
Effects of the space environment on a spacecraft and design considerations. Lecture and laboratory topics include the launch, vacuum, neutral and particulate environments. Not open to students with credit in AERO 353 or AERO 354. 2 lectures, 1 laboratory.

AERO 356. Space Environments II. 3 units
Prerequisite: AERO 299 or AERO 301; and AERO 355.
Effects of the space environment on a spacecraft and design considerations. Lecture and laboratory topics include the radiation, plasma, and thermal environments and the synergistic effects. Not open to students with credit in AERO 353 or AERO 354. 2 lectures, 1 laboratory.

AERO 357. Reentry Aerodynamics. 4 units
Prerequisite: AERO 303.
Near planet environments. Transition from orbital to aero-dynamic motion. Aerodynamic heating and effects on design. 4 lectures.

AERO 360. Creative Problem Solving in Engineering Design. 2 units
Prerequisite: PSY 350.
The creative problem solving process for an engineering design team. How to explore context and causes as part of defining a design problem; the principles of brainstorming, synthesis, and judgment. Role of iteration, implementation, and communication. Importance of a diverse view, including: customers, products, processes, systems, ethics, and professional responsibility. Team-based applications to case studies and real-world engineering design problems. 2 laboratories.

AERO 400. Special Problems for Advanced Undergraduates. 1-4 units
Prerequisite: Consent of instructor.
Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 8 units.

AERO 401. Propulsion Systems. 5 units
Prerequisite: AERO 303, CHEM 124.
Power plant types, components, characteristics, and requirements. Principles of thrust and energy utilization. Thermodynamic processes and performance of turboprop, turboshaft, turbofan, turbojet, ramjet, and rocket engines. 4 lectures, 1 laboratory.

AERO 402. Spacecraft Propulsion Systems. 5 units
Prerequisite: AERO 303; AERO 353 or AERO 355; and CHEM 124.
Effects of the propulsion subsystem on spacecraft design. Introduction to air breathing propulsion systems. Topics include basic rocket performance, monopropellant thrusters, bipropellant thrusters, electric thrusters, thruster placement, plumbing, tank sizing and design, system layout, component design, and systems integration. 4 lectures, 1 laboratory.

AERO 405. Supersonic and Hypersonic Aerodynamics. 4 units
Prerequisite: AERO 303; AERO 306 or AERO 353 or AERO 355.
Review of gas dynamics, shock-wave and boundary-layer interaction, aerodynamic design. 2-dimensional supersonic flows around thin airfoil; finite wing in supersonic flow. Local surface inclination methods for high-speed flight, boundary-layer and aerodynamic heating, viscous interactions. 4 lectures.

AERO 406. Applied Computational Fluid Dynamics. 4 units
Prerequisite: AERO 302 and AERO 306.
Application of Computational Fluid Dynamics to study a range of problems relating to applications in aerospace and automotive engineering. Grid generation, sources of errors in CFD studies, boundary conditions, 2D and 3D external flows, and turbulence modeling. 2 lectures, 2 laboratories.

AERO 407. Reentry Aerodynamics. 4 units
Prerequisite: AERO 303.
Near planet environments. Transition from orbital to aero-dynamic motion. Aerodynamic heating and effects on design. 4 lectures.
AER 408. Plasma Applications in Aerospace. 4 units
Prerequisite: PHYS 123 or PHYS 133 and senior standing.
Plasma applications in aerospace technology and operations including hypersonics, space weather, shielding, stealth, communications, power, and aerodynamics. Computational modelling of plasma and plasma theory. 4 lectures.

AER 409. Flight Test. 4 units
Prerequisite: AERO 306. Concurrent: AERO 320.
Overview of flight tests, test equations, and supporting facilities. Principles of team-centered flight testing with applications to performance, stability and control, and avionics systems testing. Test planning, instrumentation, data analysis and reports. 2 lectures, 2 laboratories.

AER 420. Aircraft Dynamics and Control. 4 units
Prerequisite: AERO 306 and AERO 320.
Newton's 6-degree-of-freedom equations of motion applied to aerospace vehicles. Stability and control derivatives, reference frames, steady-state and perturbed dynamic analyses applied to aerospace vehicles. Stability and control design principles applied to transfer functions, state-space, and modal system dynamics. 4 lectures.

AER 421. Spacecraft Attitude Dynamics and Control. 4 units
Prerequisite: AERO 320 and AERO 351.
Introduction to spacecraft attitude dynamics and control. Momentum exchange devices and bang-bang thruster control. Attitude determination (GPS), maneuvers and station keeping. Fundamentals of guidance and navigation systems. Analysis and design of control systems for aerospace vehicles. 4 lectures.

AER 425. Aircraft Performance. 4 units
Prerequisite: ME 212; AERO 306, AERO 300.

AER 431. Aerospace Structural Analysis II. 4 units
Prerequisite: AERO 331.
Basic equations of elasticity with applications to typical aerospace structures. Concepts studied include analysis of aircraft and aerospace structures; airworthiness and airframe loads; structural constraints; elementary aeroelasticity; structural instability; introduction to modern fatigue; fracture mechanics; and composite structures analysis. 4 lectures.

AER 432. Advanced Composite Structures Analysis. 4 units
Prerequisite: AERO 331.

AER 433. Experimental Stress Analysis. 1 unit
Prerequisite: AERO 331, AERO 431.
Employing the knowledge of stress analysis and aerospace structural analysis in an individual and group design project dealing with aerospace structures. 1 laboratory.

AER 434. Aerospace Structural Analysis III. 4 units
Prerequisite: AERO 431.
Analysis and design applications for aircraft and spacecraft structures. Stress concentrations, fatigue, and fracture mechanics. Structural dynamics. Framed structures, plates and shells. Composite applications. 4 lectures.

AER 435. Aerospace Numerical Analysis. 4 units
Prerequisite: AERO 300, AERO 331.

AER 443. Aircraft Design I. 3 units
System and conceptual design of an aircraft using design and calculation techniques developed in previous aerospace engineering courses. Determination of system requirements and design of a flight vehicle, including its structures and systems. Preparation of necessary drawings, briefings, and reports. Field trip required. 3 laboratories.

AER 444. Aircraft Design II. 3 units
Prerequisite: AERO 443 and senior standing.
Preliminary layout of a typical aircraft vehicle using design and calculation techniques developed in previous aerospace engineering courses. Design of a flight vehicle, including its structures and systems. Preparation of necessary drawings and a report. 3 laboratories.

AER 445. Aircraft Design III. 3 units
Prerequisite: AERO 444 and senior standing.
Preliminary layout of a typical aircraft vehicle using design and calculation techniques developed in previous aerospace engineering courses. Design of a flight vehicle, including its structures and systems. Preparation of necessary drawings and a report. 3 laboratories.

AER 446. Spacecraft Electrical and Electric Systems. 4 units
Prerequisite: AERO 353 or AERO 355; ME 212; EE 201 and EE 251.
Basic satellite types and their applications. Major subsystems of a satellite system including ground support and launch systems. Interactions between subsystems and their effects on the overall system design. Detailed analysis of key subsystems on a spacecraft with special emphasis on power and communications subsystems. 4 lectures.
AERO 447. Spacecraft Design I. 3 units
Prerequisite: IME 144; AERO 215; AERO 303; AERO 351; AERO 420 or AERO 421; AERO 431; AERO 446; and senior standing. Concurrent: AERO 402. Recommended: AERO 350; AERO 353 or AERO 355.

System and conceptual design of a space vehicle using design and calculations techniques in previous aerospace engineering courses. Determination of system requirements and design of a spacecraft or system of spacecraft. Preparation of necessary drawings, briefings and reports. Field trip required. 3 laboratories.

AERO 448. Spacecraft Design II. 3 units
Prerequisite: AERO 447.

Preliminary layout of typical space vehicle using design and calculation techniques developed in previous aerospace engineering courses. Design of selected components and preparation of necessary drawings. 3 laboratories. Open to students enrolled in the multidisciplinary design minor.

AERO 449. Spacecraft Design III. 3 units
Prerequisite: AERO 448.

Preliminary layout of typical space vehicle using design and calculation techniques developed in previous aerospace engineering courses. Design of selected components and preparation of necessary drawings. 3 laboratories. Open to students enrolled in the multidisciplinary design minor.

AERO 450. Introduction to Aerospace Systems Engineering. 4 units
Prerequisite: Senior standing or graduate standing.


AERO 452. Spaceflight Dynamics II. 4 units
Prerequisite: AERO 351.

Relative orbital motion and rendezvous, linearization of the equations of motion. Clohessy-Wiltshire equations. Two-impulse rendezvous. Asphericity of the earth, aerodynamic drag, solar radiation pressure, and n-body perturbations on an orbit. Encke, Cowell, and Variation of Parameters solution techniques. Speciality orbit due to perturbations such as low thrust trajectories, sun-synchronous, and molnyia orbits. 4 lectures.

AERO 455. Introduction to Human Spaceflight. 4 units
Prerequisite: AERO 443 or AERO 447 or graduate standing. Recommended: AERO 351; AERO 353 or AERO 355 and AERO 356.

Requirements and considerations for human spaceflight design and operations. Effects of the spaceflight environment on the human body and countermeasures to mitigate those effects. Designing a spacecraft for the human payload focusing on space operations. 4 lectures.

AERO 460. Aerospace Engineering Professional Preparation. 1 unit
Prerequisite: Senior standing.

Topics on professional development for student success including resume building and career prospecting, current events in the aerospace industry, graduate studies, engineering ethics, intellectual property, non-disclosure agreements, teamwork, and innovation and entrepreneurship. 1 activity.

AERO 463. Senior Project Laboratory I. 2 units
Prerequisite: Senior standing.

Selection and completion of a project by individuals or team which is typical of problems which graduates must solve in their fields of employment. Project involves, but is not limited to, physical modeling and testing of integrated design and may include students from other disciplines. Formulation of outline, literature review, and project schedule. 2 laboratories. Note: although AERO 463, 464 substitute for AERO 461, 462, students may not use repeat credit for the purpose of increasing GPA.

AERO 464. Senior Project Laboratory II. 3 units
Prerequisite: Senior standing.

Selection and completion of a project by individuals or team which is typical of problems which graduates must solve in their fields of employment. Project involves, but is not limited to, physical modeling and testing of integrated design and may include students from other disciplines. Formulation of outline, literature review, and project schedule. 3 laboratories. Note: although AERO 463, 464 substitute for AERO 461, 462, students may not use repeat credit for the purpose of increasing GPA.

AERO 465. Aerospace Systems Senior Laboratory. 1 unit
Prerequisite: AERO 303, AERO 320, AERO 431 and senior standing.

Culminating laboratory based experience. Experiments require the integration of the many disciplines in Aerospace Engineering. The successful completion of each experiment requires synthesis and integration of the fundamental concepts of the engineering sciences. Experimentation in the areas of aeroelasticity, active vibration control, inertial navigation, thermal control, hardware-in-the-loop simulation, and momentum exchange. 1 laboratory.

AERO 470. Selected Advanced Topics. 1-4 units
Prerequisite: Consent of instructor.

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

AERO 471. Selected Advanced Laboratory. 1-4 units
Prerequisite: Consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories.

AERO 493. Cooperative Education Experience. 2 units
CR/NC
Prerequisite: Sophomore standing and consent of instructor.

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 6 units.
AERO 494. Cooperative Education Experience. 6 units
CR/NC
Prerequisite: Sophomore standing and consent of instructor.

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 18 units.

AERO 495. Cooperative Education Experience. 12 units
CR/NC
Prerequisite: Sophomore standing and consent of instructor.

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. A more fully developed formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 24 units.

AERO 500. Individual Study. 1-4 units
Prerequisite: Consent of department head, graduate advisor and supervising faculty member.

Advanced study planned and completed under the direction of a member of the department faculty. Open only to graduate students who have demonstrated ability to do independent work. Enrollment by petition. Total credit limited to 12 units.

AERO 512. Aerospace Vehicle Software Application. 4 units
Prerequisite: Graduate standing.


AERO 513. Applications of Unmanned Aircraft Systems. 4 units
Prerequisite: AERO 306 or AERO 351 or graduate standing.

Engineering development and analysis of unmanned aircraft systems (UAS) as airborne tools for societal benefit. Use of UAS for military, public service, and commercial purposes. Characterization of missions and applications. Development of system requirements and concepts of operation. Evaluation of relative merits and limitations of UAS. 4 lectures.

AERO 515. Continuum Mechanics. 4 units
Prerequisite: Graduate standing or consent of instructor.


AERO 517. Multidisciplinary Design and Optimization. 4 units
Prerequisite: AERO 300 (or similar MATLAB course) or graduate standing.

Numerical optimization applied to the design of complex systems. Multi-criteria decision making, unconstrained and constrained optimization methods, system sensitivity analysis, system decomposition techniques, and multidisciplinary design optimization. 4 lectures.

AERO 519. Fundamentals of Vehicle Dynamics and Control. 4 units
Prerequisite: Graduate standing or consent of instructor.


AERO 522. Boundary-Layer Theory. 4 units
Prerequisite: AERO 302 or graduate standing.

Concept of boundary-layer. Boundary-layer equations, similarity transformation, integral and differential methods for steady, two-dimensional laminar and turbulent boundary layers. 4 lectures.

AERO 523. Turbulence. 4 units
Prerequisite: AERO 302 or graduate standing.


AERO 525. Computational Fluid Dynamics. 4 units
Prerequisite: AERO 303 or graduate standing.


AERO 526. Spacecraft Thermal/Fluid Control. 4 units
Prerequisite: AERO 299 or AERO 301; AERO 302; AERO 303; or graduate standing.


AERO 528. Laminar Flow Aircraft Development. 4 units
Prerequisite: AERO 306 and AERO 307; or graduate standing.

Fundamentals of laminar boundary layers in the design of aircraft. History and development of laminar flow aircraft. Modern approaches to designing for laminar flow. Analysis and testing of laminar flow designs and determination of practical limits for laminar flow application. 4 lectures.

AERO 529. Turbulence and Flow Control. 4 units
Prerequisite: AERO 307 or graduate standing.

Physics and analysis of turbulence. Vorticity, mixing, jets, wakes, boundary layer transition, scales and structures. Effects of turbulence on noise and aerodynamics. Experiments and simulations in boundary layer transition, separation phenomena, passive and active flow control. Not open to students with credit in AERO 523. 2 lectures, 2 laboratories.
AERO 531. Airworthiness and Aeroelasticity. 4 units
Prerequisite: AERO 431 or graduate standing.
Fundamentals of airworthiness and aeroelasticity of flight vehicles. Flight
envelope and aircraft loads. Loads and normal acceleration for
various maneuvers. Gust loads. Load distribution and diversions. Control
effectiveness and reversal. Fatigue and structural vibration. Introduction
to flutter. 3 lectures, 1 laboratory.

AERO 532. Advanced Aerospace Composite Design. 4 units
Prerequisite: Graduate standing or consent of instructor.
Behavior of composite materials. Bending, buckling, and vibration of
laminated plates. Fatigue and fracture mechanics analysis of composite
structures. Optimum design of composite pressure vessels. 2 seminars, 2
laboratories.

AERO 533. Finite Elements for Aerospace Structural Analysis. 4 units
Prerequisite: AERO 431.
Overview of theoretical and applied methods of finite element analysis
for aerospace structures including composite and light weight structures.
Topics include basic equations of elasticity, solutions of linear systems of
equations transformation, global stiffness matrix, Bernoulli-Euler element,
plane stress triangles, finite element formulation, isoparametric elements,
alternative formulation, eigenvalue problems and dynamic analysis. 3
lectures, 1 laboratory.

AERO 534. Aerospace Structural Dynamics Analysis. 4 units
Prerequisite: Graduate standing.
Structural dynamics and aeroelasticity of flight vehicles. Vibration and
forced response of continuous structures. Introduction to unsteady
aerodynamic analysis methods. Normal-Mode Method and Modal
Analysis. Framed structures and rigid body structures. Airworthiness and
aeroelasticity. Random Vibrations. 3 lectures, 1 laboratory.

AERO 535. Advanced Aerospace Structural Analysis. 4 units
Prerequisite: Graduate standing or consent of instructor.
Types of failure. Theories of failure. Stability of structures. Advanced
flight vehicle and fracture mechanics analysis and design. Fundamentals
and applications of modern fatigue analysis in the aerospace industry. 3
lectures, 1 laboratory.

AERO 540. Elements of Rocket Propulsion. 4 units
Prerequisite: AERO 303, AERO 401 or 402, or graduate standing.
Thrust and impulse equations, propellant composition and mixture
ratios, nozzle expansion ratios, solid and liquid propellant combustion,
internal ballistics, thermo-chemical computations, chemical kinetics, and
combustion instability, nozzle design and exhaust plumes. 4 seminars.

AERO 541. Air Breathing Propulsion. 4 units
Prerequisite: AERO 401 or graduate standing.
Aerothermodynamics of propulsion systems, power plant selection
and design, on-off design performance, component characterization,
component design, component matching, optimization, and introduction
to power plant and airframe integration systems for aircraft. 4 seminars.

AERO 542. Electric and Advanced Propulsion. 4 units
Prerequisite: AERO 402 or graduate standing.
Electric propulsion operation, performance, selection and integration.
Nuclear propulsion concepts, performance, and political and
environmental concerns. Propellant-less propulsion techniques. Current
state-of-the-art and developing technologies. 4 lectures.

AERO 546. Spacecraft Systems Design. 4 units
Prerequisite: Graduate standing.
Spacecraft missions, vehicle types, and applications. Introduction and
preliminary sizing of major subsystems of a space system. Introduction
to and design drivers for space environments, propulsion system, power
system, structural design, spacecraft dynamics and attitude control, orbit
mechanics, thermal control, communications, and ground segments. 4
lectures.

AERO 549. Systems Engineering Applications. 4 units
Prerequisite: AERO 450 or graduate standing.
Systems engineering principles and methods. Program planning,
scheduling and budgeting, risk management, and design strategies
to meet system/mission requirements. Quality function development
and quality control concepts. Proposal development, evaluation, and
selection. Not open to students with credit in AERO/IME 510 or AERO/
IME 511. 4 lectures.

AERO 551. Global Positioning Satellite Navigation Systems. 4 units
Prerequisite: Graduate standing.
Principles of Global Positioning Satellite navigation systems. Kalman
filter design and application to integrated navigation and guidance
systems. Statistical evaluation and test methods in aerospace.
Interactive computer simulations. 3 lectures, 1 laboratory.

AERO 553. Advanced Control Theory. 4 units
Prerequisite: AERO 320 or graduate standing.
Advanced control theory techniques. Analytical and computational
methods applied to dynamic systems. State space system
representation, solutions to dynamic systems, non-linear and linear
stability analysis, full-state and output feedback, controllability and
observability and advanced control topics (LQR/LQG, Kalman Filters,
Adaptive Control, etc.). 4 lectures.

AERO 557. Advanced Orbital Mechanics. 4 units
Prerequisite: AERO 351 or graduate standing.
Initial orbit determination using angles only methods. Various Solutions
to Lambert’s Problem. Orbit and transfer optimization, libration points,
halo orbits, and secondary orbit perturbations. 4 lectures.

AERO 560. Advanced Spacecraft Dynamics and Control. 4 units
Prerequisite: AERO 421 or graduate standing.
Attitude determination and control of rigid spacecraft via reaction wheels,
control moment gyros and thrusters. Modeling, analysis and control of
flexible spacecraft. Non-linear stability theory as applied to spacecraft. 4
lectures.
AERO 561. Vehicle Integration and Testing. 2 units  
Prerequisite: AERO 350 or AERO 446, or graduate standing.

Space vehicle integration requirements and procedures. Clean room requirements and operations. Quality control and inspection. Qualification and acceptance testing requirements. Test equipment. Vibration and shock testing. Space environment and thermal-vac testing. Development of test procedures. 1 lecture, 1 laboratory.

AERO 562. Space Operations. 2 units  
Prerequisite: AERO 350 or AERO 446, or graduate standing.


AERO 565. Advanced Topics in Aircraft Design. 4 units  
Prerequisite: AERO 445 or graduate standing.

Application of advanced analytic engineering methods to aircraft design problems. Analysis and synthesis of advanced topics related to design of aircraft. 4 lectures.

AERO 566. Advanced Topics in Spacecraft Design. 4 units  
Prerequisite: AERO 449 or graduate standing.

Application of advanced engineering tools to the design of space vehicles. System architecture and mission design. Concept of operations. Requirements development and flow down. System and subsystems trade studies and preliminary design. 4 lectures.

AERO 567. Launch Vehicle and Missile Design. 4 units  
Prerequisite: AERO 401 or 402; or graduate standing. Recommended: AERO 350.

Basic launch vehicle/missile types. Launch vehicle subsystems and their interactions. Vehicle requirements development and flow down. Payload accommodations. System and subsystems trade studies and preliminary design. 4 lectures.

AERO 568. Aerodynamic Research and Development I. 4 units  
Prerequisite: AERO 302 and AERO 406.

Immersive team-based approach to an aerodynamic research and development cycle. Theoretical work, preliminary design based upon computational fluid dynamics, and model manufacture. Advanced techniques in multi-variable wind tunnel tests. Validation of numerical work using correlation techniques. Field trip may be required. Total credit limited to 8 units. 2 lectures, 2 laboratories.

AERO 569. Aerodynamic Research and Development II. 4 units  
Prerequisite: AERO 568.

Continuation of AERO 568. Single or multi-variable design optimization cycle based upon computational fluid dynamics. Numerical and experimental experimentation, high-fidelity validation and correlation of testing data, and archival-quality technical reporting of aerodynamic data and analysis. Total credit limited to 8 units. 2 lectures, 2 laboratories.

AERO 570. Selected Advanced Topics. 4 units  
Prerequisite: Graduate standing or consent of instructor.

Directed group study of selected topics for graduate students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 4 lectures.

AERO 571. Selected Advanced Topics Laboratory. 1-4 units  
Prerequisite: Graduate standing or consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories.

AERO 593. Cooperative Education Experience. 2 units  
CR/NC  
Prerequisite: Graduate standing and consent of instructor.

Advanced study analysis and part-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Credit/No Credit grading only.

AERO 594. Cooperative Education Experience. 6 units  
CR/NC  
Prerequisite: Graduate standing and consent of instructor.

Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Credit/No Credit grading only.

AERO 595. Cooperative Education Experience. 12 units  
CR/NC  
Prerequisite: Graduate standing and consent of instructor.

Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. A fully-developed formal report and evaluation by work supervisor required. Credit/No Credit grading only.

AERO 596. Culminating Experience in Space Systems Engineering. 5 units  
Prerequisite: Graduate standing.

Performance of comprehensive systems analysis of a space system. Communication of the results and findings of such evaluations in written report and by oral presentation. Conducted under supervision of faculty.

AERO 599. Thesis (Design Project). 1-9 units  
Prerequisite: Graduate standing.

Each individual or group will be assigned a project for solution under faculty supervision as a requirement for the master's degree, culminating in a written report/thesis.