AEROSPACE ENGINEERING (AER E)

Courses primarily for undergraduates:

AER E 160: Aerospace Engineering Problems With Computer Applications Laboratory
(2-2) Cr. 3. F.S.
Prereq: MATH 143 or satisfactory scores on mathematics placement examinations; credit or enrollment in MATH 165

AER E 160H: Aerospace Engineering Problems With Computer Applications Laboratory: Honors
(2-2) Cr. 3. F.S.
Prereq: MATH 143 or satisfactory scores on mathematics placement examinations; credit or enrollment in MATH 165

AER E 161: Numerical, Graphical and Laboratory Techniques for Aerospace Engineering
(2-2) Cr. 3. F.S.
Prereq: Credit or enrollment in AER E 160 or equivalent course
Computer-based problem solving using Matlab(R), with emphasis on numerical methods. Introduction to solid modeling and aerospace design using SolidWorks.

AER E 161H: Numerical, Graphical and Laboratory Techniques for Aerospace Engineering: Honors
(2-2) Cr. 3. F.S.
Prereq: AER E 160 or equivalent course
Computer-based problem solving using Matlab(R), with emphasis on numerical methods. Introduction to solid modeling and aerospace design using SolidWorks.

AER E 192: Aerospace Seminar
Cr. R. S.
Vectors, differentiation, integration, matrices, and systems of linear equations.

Cr. R. S.
Vectors, differentiation, integration, matrices, and systems of linear equations.

AER E 261: Introduction to Performance and Design
(3-0) Cr. 3. F.S.
Prereq: MATH 166, PHYS 221, credit or enrollment in AER E 161
Aerodynamics of the airplane, lift and drag, drag polar, propulsion characteristics of turbojets and piston props, level flight, range, endurance, climbing flight, turning flight, take-off and landing, design examples.

AER E 265: Scientific Balloon Engineering and Operations
(Cross-listed with MTEOR). (0-2) Cr. 1. Repeatable. F.
Engineering aspects of scientific balloon flights. Integration of science mission objectives with engineering requirements. Operations team certification. FAA and FCC regulations, communications, and command systems. Flight path prediction and control.

AER E 290: Aerospace Engineering Independent Study: Independent Study
Cr. R. F.S.
Prereq: Sophomore classification, approval of the department
AER E 290A: Aerospace Engineering Independent Study: Flight ground instruction
Cr. 1-2. Repeatable.
Prereq: Sophomore classification, approval of the department
AER E 290B: Aerospace Engineering Independent Study: In-flight training
Cr. 1-2. Repeatable.
Prereq: AER E 301
AER E 290C: Aerospace Engineering Independent Study: Other
Cr. 1-2. Repeatable.
Prereq: AER E 301

AER E 301: Flight Experience
Cr. R. F.S.
Prereq: Credit or enrollment in AER E 355
Two hours of in-flight training and necessary ground instruction. Course content prescribed by the Aerospace Engineering Department. Ten hours of flight training certified in a pilot log book can be considered by the course instructor as evidence of satisfactory performance in the course. Offered on a satisfactory-fail basis only.
AER E 310: Aerodynamics I: Incompressible Flow
(3-0) Cr. 3. F.S.
Prereq: Grade of C- or better in AER E 261 and MATH 265

AER E 311: Aerodynamics II: Compressible Flow
(3-0) Cr. 3. F.S.
Prereq: AER E 310, M E 231

AER E 321: Flight Structures Analysis
(3-0) Cr. 3. F.S.
Prereq: E M 324, Credit or enrollment in MATH 266 or 267

AER E 322: Aerospace Structures Laboratory
(1-2) Cr. 2. F.S.
Prereq: Credit or enrollment in AER E 321

AER E 331: Flight Control Systems I
(3-0) Cr. 3. F.S.
Prereq: AER E 355
Linear system analysis. Control system designs using root-locus and frequency response methods. Applications in flight control systems.

AER E 344: Aerodynamics and Propulsion Laboratory
(2-2) Cr. 3. F.S.
Prereq: AER E 310; Coreq: AER E 311

AER E 351: Astrodynamics I
(3-0) Cr. 3. F.S.
Prereq: E M 345

AER E 355: Aircraft Flight Dynamics and Control
(3-0) Cr. 3. F.S.
Prereq: AER E 261, MATH 267, E M 345
Aircraft rigid body equations of motion, linearization, and modal analysis. Longitudinal and lateral-directional static and dynamic stability analysis. Flight handling characteristics analysis. Longitudinal and lateral-directional open loop response to aircraft control inputs. Aircraft flight handling qualities.

AER E 361: Computational Techniques for Aerospace Design
(2-2) Cr. 3. F.S.
Prereq: AER E 310, MATH 267, E M 324, E M 345
Advanced programming, workstation environment, and development of computational tools for aerospace analysis and design. Technical report writing.

AER E 362: Aerospace Systems Integration
(3-0) Cr. 3. F.S.
Prereq: Junior standing in Aerospace Engineering or permission of instructor
Emphasis on impact of component interfaces in aerospace systems. Understand how changes in variables associated with individual components impact the performance of the aerospace system. Specific integration challenges include: capturing implicit disciplinary interactions (e.g. structures/aerodynamics, propulsion/aerodynamics, etc.), propagating tolerances through the system (i.e. uncertainty modeling), balancing component attributes in the system objective.

AER E 381: Introduction to Wind Energy
(3-0) Cr. 3. S.
Prereq: MATH 166, PHYS 221
Basic introduction to the fundamentals of Wind Energy and Wind Energy conversion systems. Topics include but not limited to various types of wind energy conversion systems and the aerodynamics, blade and tower structural loads, kinematics of the blades and meteorology.
AER E 396: Summer Internship  
Cr. R. Repeatable. SS.
Prereq: Permission of department and Engineering Career Services  
Professional work period of at least 10 weeks during the summer.  
Students must register for this course prior to commencing work. Offered on a satisfactory-fail basis only.

AER E 398: Cooperative Education  
Cr. R. Repeatable. F.S.  
Prereq: Permission of department and Engineering Career Services.  
Professional work period. One semester per academic or calendar year.  
Students must register for this course prior to commencing work. Offered on a satisfactory-fail basis only.

AER E 411: Aerospace Vehicle Propulsion I  
(3-0) Cr. 3. F.S.  
Prereq: AER E 311, AER E 344  
Atmospheric propulsion system performance and cycle analysis.  
Momentum theorem, thrust and propulsive efficiency. Thermodynamics of compressible flow with heat and work addition. Components and principles of turbojets and turbofans. Rocket engines and ramjet principles.

AER E 412: Aerospace Vehicle Propulsion II  
(3-0) Cr. 3. S.  
Prereq: AER E 311  
Introduction to advanced electromagnetic propulsion systems. Energy sources and nuclear propulsion. Space mission requirements.

AER E 417: Experimental Mechanics  
Dual-listed with AER E 517. (Cross-listed with E M). (2-2) Cr. 3. Alt. F., offered even-numbered years.  
Prereq: E M 324; MAT E 273  
Introduction to fundamental concepts for force, displacement, stress and strain measurements for structures and materials applications.  
Strain gage theory and application. Full field deformation measurements with laser interferometry and digital image processing. Advanced experimental concepts at the micro- and nano-scale regimes. Selected laboratory experiments.

AER E 421: Advanced Flight Structures  
(2-2) Cr. 3. F.S.  
Prereq: AER E 321, MATH 266 or MATH 267  
Analysis of indeterminate flight structures including finite element laboratory. Static analysis of complex structural components subject to thermal and aerodynamic loads. Analytical and finite element solutions for stresses and displacements of membrane, plane stress, plate structures. Buckling of beams, frames, and plate structures. Introduction to vibration of flight structures. Steady state and transient structural response using normal modal analysis.

AER E 422: Vibrations and Aeroelasticity  
(3-0) Cr. 3. Alt. S., offered even-numbered years.  
Prereq: E M 324 or AER E 321  

AER E 423: Composite Flight Structures  
(2-2) Cr. 3. S.  
Prereq: E M 324; MAT E 273  
Fabrication, testing and analysis of composite materials used in flight structures. Basic laminate theory of beams, plates and shells. Manufacturing and machining considerations of various types of composites. Testing of composites for material properties, strength and defects. Student projects required.

AER E 426: Design of Aerospace Structures  
(Dual-listed with AER E 526). (2-2) Cr. 3. F.  
Prereq: E M 324  
Detailed design and analysis of aerospace vehicle structures. Material selection, strength, durability and damage tolerance, and validation analysis. Design for manufacturability.

AER E 432: Flight Control Systems II  
(3-0) Cr. 3. F.  
Prereq: AER E 331  
AER E 433: Spacecraft Dynamics and Control
(3-0) Cr. 3. F.
Prereq: EM 345
Three-dimensional rotational kinematics and attitude dynamics of a rigid body in space. Stability analysis of a spinning spacecraft with or without energy dissipation. Attitude dynamics and stability of a satellite in circular orbit. Introduction to spacecraft attitude determination and control systems (ADCS). Simulation of spacecraft attitude-dynamics and control problems of practical interest using MATLAB.

AER E 442: V/STOL Aerodynamics and Performance
(3-0) Cr. 3. F.
Prereq: AER E 261
Introduction to the aerodynamics, performance, stability, control and critical maneuvering characteristics of V/STOL vehicles. Topics include hovercrafts, jet flaps, ducted fans and thrust vectored engines.

AER E 446: Computational Fluid Dynamics
(3-0) Cr. 3. F.
Prereq: AER E 311, AER E 361 and proficiency in at least one programming language

AER E 448: Fluid Dynamics of Turbomachinery
(Cross-listed with M E). (3-0) Cr. 3. S.
Prereq: AER E 311 or M E 335
Applications of principles of fluid mechanics and thermodynamics in performance analysis and design of turbomachines. Conceptual and preliminary design of axial and radial flow compressors and turbines using velocity triangles and through-flow approaches.

AER E 451: Astrodynamics II
(3-0) Cr. 3. F.S.
Prereq: AER E 351
Orbit determination and prediction using Gibb's and Gauss’ methods. Advanced orbit maneuvers, triple-, and fixed-impulse; universal variables; Kepler’s problem. Earth gravity field models and gravity harmonics, orbit perturbations, advanced dynamics, variational methods, relative orbital mechanics, and Clohessy-Wiltshire equations.

AER E 461: Modern Design Methodology with Aerospace Applications
(2-2) Cr. 3. F.S.
Prereq: AER E 361, AER E 311, AER E 321, AER E 322, AER E 344, AER E 351, AER E 355
Introduction to modern engineering design methodology. Computational constrained optimal design approach including selection of objective function, characterization of constraint system, materials and strength considerations, and sensitivity analyses.

AER E 462: Design of Aerospace Systems
(1-4) Cr. 3. F.S.
Prereq: AER E 461
Fundamental principles used in engineering design of aircraft, missile, and space systems. Preliminary design of aerospace vehicles. Engineering Ethics.

AER E 463: Introduction to Multidisciplinary Design Optimization
(Dual-listed with AER E 563). (3-0) Cr. 3. F.
Prereq: senior standing in College of Engineering or permission of instructor
Introduction to the theory and methods of Multidisciplinary Design Optimization (MDO), including system coupling, system sensitivity methods, decomposition methods, MDO formulations (such as multi-discipline feasible (MDF), individual discipline feasible (IDF) and all-at-once (AAO) approaches, and MDO search methods.

AER E 464: Spacecraft Systems
(3-0) Cr. 3. S.
Prereq: AER E 351
An examination of spacecraft systems including attitude determination and control, power, thermal control, communications, propulsion, guidance, navigation, command and data handling, and mechanisms. Explanation of space and operational environments as they impact spacecraft design. Includes discussion of safety, reliability, quality, maintainability, testing, cost, legal, and logistics issues.

AER E 466: Multidisciplinary Engineering Design
(Cross-listed with A B E, B M E, CPR E, E E, ENGR, I E, M E, MAT E). (1-4) Cr. 3. Repeatable. F.S.
Prereq: Student must be within two semesters of graduation; permission of instructor.
Application of team design concepts to projects of a multidisciplinary nature. Concurrent treatment of design, manufacturing, and life cycle considerations. Application of design tools such as CAD, CAM, and FEM. Design methodologies, project scheduling, cost estimating, quality control, manufacturing processes. Development of a prototype and appropriate documentation in the form of written reports, oral presentations and computer models and engineering drawings.
AER E 467: Multidisciplinary Engineering Design II
(Cross-listed with CPR E, E E, ENGR, I E, M E, MAT E). (1-4) Cr. 3.
*Prereq: Student must be within two semesters of graduation or receive permission of instructor.
Build and test of a conceptual design. Detail design, manufacturability, test criteria and procedures. Application of design tools such as CAD and CAM and manufacturing techniques such as rapid prototyping. Development and testing of a full-scale prototype with appropriate documentation in the form of design journals, written reports, oral presentations and computer models and engineering drawings.

AER E 468: Large-Scale Complex Engineered Systems (LSCES)
(Dual-listed with AER E 568). (Cross-listed with I E). (3-0) Cr. 3.
*Prereq: senior standing in College of Engineering or permission of AerE 468 instructor
Introduction to the theoretical foundation and methods associated with the design for large-scale complex engineered systems, including objective function formation, design reliability, value-driven design, product robustness, utility theory, economic factors for the formation of a value function and complexity science as a means of detecting unintended consequences in the product behavior.

AER E 480: Ultrasonic Nondestructive Evaluation
(Cross-listed with E M). (3-0) Cr. 3.
*Prereq: E M 324, MATH 266 or MATH 267, PHYS 222
Introduction to stress/strain, Hooke's law, and elastic wave propagation in two dimensions in isotropic media. Ultrasonic plane-wave reflection and transmission; and simple straight-crested guided waves. Transducer construction, behavior, and performance. Simple signal analysis and discrete signal processing. The last few weeks of the course are devoted to case studies.

AER E 481: Advanced Wind Energy: Technology and Design
(3-0) Cr. 3.
*Prereq: AER E 381 or senior classification in engineering or junior in engineering with a course in fluid mechanics
Advanced topics in wind energy, emphasis on current practices. Theoretical foundations for horizontal and vertical axis wind turbine. Design codes for energy conversion systems design, aerodynamic and structural load estimation, wind resource characterization wind farm design, optimization.

AER E 490: Aerospace Engineering Independent Study
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
AER E 490A: Aerospace Engineering Independent Study: Aero and/or Gas Dynamics
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
AER E 490B: Aerospace Engineering Independent Study: Propulsion
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
AER E 490C: Aerospace Engineering Independent Study: Aerospace Structures
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
AER E 490D: Aerospace Engineering Independent Study: Flight Dynamics
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
AER E 490E: Aerospace Engineering Independent Study: Spacecraft Systems
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
AER E 490F: Aerospace Engineering Independent Study: Flight Control Systems
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
AER E 490G: Aerospace Engineering Independent Study: Aerelasticity
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
AER E 490H: Aerospace Engineering Independent Study: Independent Study, Honors
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
AER E 490I: Aerospace Engineering Independent Study: Design
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
AER E 490K: Aerospace Engineering Independent Study: Wind Engineering
Cr. 1-6. Repeatable.
*Prereq: Junior or senior classification, approval of the department
Cr. 1-6. Repeatable.
Prereq: Junior or senior classification, approval of the department

AER E 490O: Aerospace Engineering Independent Study: Other
Cr. 1-6. Repeatable.
Prereq: Junior or senior classification, approval of the department

AER E 499: Senior Project
Cr. 1-2. Repeatable. F.S.
Prereq: Senior classification, credit or enrollment in AER E 491
Development of aerospace principles and concepts through individual research and projects. Written report.

Courses primarily for graduate students, open to qualified undergraduates:

AER E 501: Advanced Engineering Analysis
(3-0) Cr. 3. F.
Prereq: Math 267 or equivalent
Linear ordinary differential equations with variable coefficients; hyperbolic, parabolic, and elliptic equations; tensors. None

AER E 511: Wind Energy System Design
(Cross-listed with WESEP). (3-0) Cr. 3.
Prereq: WESEP 501 and WESEP 502
Advanced design, control, and operation of wind plants. Topics include electromechanical energy conversion systems, aerodynamic and aeroelastic loads, optimal control of wind farms, life cycle management strategies, tall tower design, and prediction of component residual life.

AER E 514: Advanced Mechanics of Materials
(Cross-listed with E M). (3-0) Cr. 3.
Prereq: E M 324
Introduction to geometric and material nonlinearities.

AER E 517: Experimental Mechanics
(Dual-listed with AER E 417). (Cross-listed with E M). (2-2) Cr. 3. Alt. F., offered even-numbered years.
Prereq: E M 324, MAT E 273
Introduction to fundamental concepts for force, displacement, stress and strain measurements for structures and materials applications. Strain gage theory and application. Full field deformation measurements with laser interferometry and digital image processing. Advanced experimental concepts at the micro- and nano-scale regimes. Selected laboratory experiments.

AER E 521: Airframe Analysis
(3-0) Cr. 3. F.
Prereq: AER E 421 or E M 424
Analysis of static stresses and deformation in continuous aircraft structures. Various analytical and approximate methods of analysis of isotropic and anisotropic plates and shells.

AER E 522: Design and Analysis of Composite Materials
(3-0) Cr. 3. F.
Prereq: E M 324
Composite constituent materials, micro-mechanics, laminate analysis, hygro-thermal analysis, composite failure, joining of composites, design of composite beams and plates, honeycomb core, manufacturing of composites, short fiber composites, and demonstration laboratory.

AER E 524: Numerical Mesh Generation
(3-0) Cr. 3. F.
Prereq: MATH 385, proficiency in programming
Introduction to modern mesh generation techniques. Structured and unstructured mesh methods, algebraic and PDE methods, elliptic and hyperbolic methods, variational methods, error analysis, Delaunay triangulation, data structures, geometric modeling with B-spline and NURBS surfaces, surface meshing.

AER E 525: Finite Element Analysis
(Cross-listed with E M). (3-0) Cr. 3. S.
Prereq: E M 425, MATH 385
Variational and weighted residual approach to finite element equations. Emphasis on two- and three-dimensional problems in solid mechanics. Isoparametric element formulation, higher order elements, numerical integration, imposition of constraints and penalty, convergence, and other more advanced topics. Use of two- and three-dimensional computer programs. Dynamic and vibrational problems, eigenvalues, and time integration. Introduction to geometric and material nonlinearities.

AER E 526: Design of Aerospace Structures
(Dual-listed with AER E 426). (2-2) Cr. 3. F.
Prereq: E M 324
Detailed design and analysis of aerospace vehicle structures. Material selection, strength, durability and damage tolerance, and validation analysis. Design for manufacturability.

AER E 531: Automatic Control of Flight Vehicles
(3-0) Cr. 3. S.
Prereq: AER E 331
Applications of classical and modern linear control theory to automatic control of flight vehicles. Spacecraft attitude control. Control of flexible vehicles. Linear-quadratic regulator design applications.
AER E 532: Compressible Fluid Flow
(Cross-listed with M E). (3-0) Cr. 3. S.
Prereq: AER E 310, 311 or equivalent
Thermodynamics of compressible flow. Viscous and inviscid
compressible flow equations. One dimensional steady flow; isentropic
flow, shocks, expansions. Multidimensional compressible flow aspects.
Linear and nonlinear wave analysis and method of characteristics.
Subsonic, transonic, supersonic and hypersonic flows.

AER E 541: Incompressible Flow Aerodynamics
(3-0) Cr. 3. F.
Prereq: AER E 310 or ME 335 or equivalent
Kinematics and dynamics of fluid flow. Derivation of the Navier-Stokes,
Euler and potential flow equations. Introduction to generalized curvilinear
coordinates. Ideal fluids. Two-dimensional and three-dimensional
potential flow. Complex variable methods.

AER E 545: Experimental Flow Mechanics and Heat Transfer
(3-0) Cr. 3. F.
Prereq: AER E 310 or ME 335 or E M 378
Similitude and dimensional analysis. Measurement uncertainty
analysis; Fluid mechanical apparatus: wind tunnel and water tunnels.
Various experimental techniques widely used for fluid mechanics,
aerodynamics, heat transfer, and combustion studies: Pressure gauge
and transducers; Pitot tube; hot wire anemometry; Shadowgraph and
Schlieren Photography; laser Doppler velocimetry; particle image
velocimetry (PIV); advanced PIV techniques (stereo PIV, 3-D PIV,
Tomographic PIV, Holograph PIV and microscopic PIV); laser induced
fluorescence; pressure sensitive painting, temperature sensitive painting;
molecular tagging velocimetry; molecular tagging thermometry. Extensive
applications and laboratory experiments will be included.

AER E 546: Computational Fluid Mechanics and Heat Transfer I
(Cross-listed with M E). (3-0) Cr. 3. F.
Prereq: AER E 310 or M E 335 or E M 378
Basic concepts of discretization, consistency, and stability. Explicit and
implicit methods for ordinary differential equations. Methods for each
type of partial differential equation. Iterative solution methods; curvilinear
grids. Students will program basic algorithms.

AER E 547: Computational Fluid Mechanics and Heat Transfer II
(Cross-listed with M E). (3-0) Cr. 3. S.
Prereq: AER E 546 or equivalent
Application of computational methods to current problems in fluid
mechanics and heat transfer. Methods for solving the Navier-Stokes and
reduced equation sets such as the Euler, boundary layer, and parabolized
forms of the conservation equations. Introduction to relevant aspects of
grid generation and turbulence modeling.

AER E 551: Orbital Mechanics
(3-0) Cr. 3. F.
Prereq: AER E 351
Orbit perturbation analysis. Gravity field expansions and effects on
orbiters. 3-body problem with applications.

AER E 556: Guidance and Navigation of Aerospace Vehicles
(3-0) Cr. 3. F.
Prereq: AER E 331
Principles of guidance systems for spacecraft, launch vehicles, homing
and ballistic missiles. Optimal guidance. Interplanetary transfer guidance
with low thrust. Principles of inertial navigation. Theory and applications
Application of Kalman filtering to recursive navigation theory.

AER E 563: Introduction to Multidisciplinary Design Optimization
(Dual-listed with AER E 463). (3-0) Cr. 3. F.
Prereq: senior standing in College of Engineering or permission of instructor
Introduction to the theory and methods of Multidisciplinary Design
Optimization (MDO), including system coupling, system sensitivity
methods, decomposition methods, MDO formulations (such as multi-
discipline feasible (MDF), individual discipline feasible (IDF) and all-at-
once (AAO) approaches, and MDO search methods.

AER E 564: Fracture and Fatigue
(Cross-listed with E M, M E, M S E). (3-0) Cr. 3. Alt. F., offered even-
numbered years.
Prereq: E M 324 and either MAT E 216 or MAT E 273 or MAT E 392.
Undergraduates: Permission of instructor
Materials and mechanics approach to fracture and fatigue.
Fracture mechanics, brittle and ductile fracture, fracture and fatigue
characteristics, fracture of thin films and layered structures. Fracture
and fatigue tests, mechanics and materials designed to avoid fracture or
fatigue.

AER E 565: Systems Engineering and Analysis
(Cross-listed with E E, I E). (3-0) Cr. 3.
Prereq: Coursework in basic statistics
Introduction to organized multidisciplinary approach to designing and
developing systems. Concepts, principles, and practice of systems
engineering as applied to large integrated systems. Life-cycle costing,
scheduling, risk management, functional analysis, conceptual and
detail design, test evaluation, and systems engineering planning and
organization. Not available for degrees in industrial engineering
AER E 566: Avionics Systems Engineering
(Cross-listed with E E). (3-0) Cr. 3. S.
Prereq: E E 565
Avionics functions. Applications of systems engineering principles to avionics. Top-down design of avionics systems. Automated design tools.

AER E 568: Large-Scale Complex Engineered Systems (LSCES)
(Dual-listed with AER E 468). (Cross-listed with I E). (3-0) Cr. 3. S.
Prereq: senior standing in College of Engineering or permission of AerE 468 instructor
Introduction to the theoretical foundation and methods associated with the design for large-scale complex engineered systems, including objective function formation, design reliability, value-driven design, product robustness, utility theory, economic factors for the formation of a value function and complexity science as a means of detecting unintended consequences in the product behavior.

AER E 569: Mechanics of Composite and Combined Materials
(Cross-listed with E M, M S E). (3-0) Cr. 3. Alt. S., offered even-numbered years.
Prereq: E M 324

AER E 570: Wind Engineering
(Cross-listed with E M). (3-0) Cr. 3. Alt. S., offered odd-numbered years.
Prereq: E M 378, E M 345
Atmospheric circulations, atmospheric boundary layer wind, bluff-body aerodynamics, aeroelastic phenomena, wind-tunnel and full-scale testing, wind-load code and standards, effect of tornado and thunderstorm winds, design applications.

AER E 572: Turbulence
(Cross-listed with CH E). (3-0) Cr. 3.
Prereq: AER E 541 or M E 538

AER E 573: Random Signal Analysis and Kalman Filtering
(Cross-listed with E E, M E). (3-0) Cr. 3. F.
Prereq: E E 324 or AER E 331 or M E 370 or M E 411 or MATH 341

AER E 574: Optimal Control
(Cross-listed with E E, M E). (3-0) Cr. 3. S.
Prereq: E E 577

AER E 575: Introduction to Robust Control
(Cross-listed with E E, M E). (3-0) Cr. 3.
Prereq: E E 577

AER E 576: Digital Feedback Control Systems
(Cross-listed with E E, M E). (3-0) Cr. 3. F.
Prereq: E E 475 or AER E 432 or M E 411 or MATH 267

AER E 577: Linear Systems
(Cross-listed with E E, M E, MATH). (3-0) Cr. 3. F.
Prereq: E E 324 or AER E 331 or MATH 415; and MATH 207
AER E 578: Nonlinear Systems
(Cross-listed with E E, M E, MATH). (3-0) Cr. 3. S.
Prereq: E E 577

AER E 581: Perturbation Methods
(3-0) Cr. 3. F.
Prereq: MATH 267

AER E 590: Aerospace Engineering Independent Study: Special Topics
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590A: Aerospace Engineering Independent Study: Aero and/or Gas Dynamics
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590B: Aerospace Engineering Independent Study: Propulsion
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590C: Aerospace Engineering Independent Study: Aerospace Structures
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590D: Aerospace Engineering Independent Study: Flight Dynamics
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590E: Aerospace Engineering Independent Study: Spacecraft Systems
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590F: Aerospace Engineering Independent Study: Flight Control Systems
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590G: Aerospace Engineering Independent Study: Aeroelasticity
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590H: Aerospace Engineering Independent Study: Viscous Aerodynamics
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590I: Aerospace Engineering Independent Study: Design
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590J: Aerospace Engineering Independent Study: Hypersonics
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590K: Aerospace Engineering Independent Study: Computational Aerodynamics
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590L: Aerospace Engineering Independent Study: Optimization
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590M: Aerospace Engineering Independent Study: Non Destructive Evaluation
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 590N: Aerospace Engineering Independent Study: Wind Engineering
Cr. 1-5. Repeatable, maximum of 3 times.

AER E 591: Graduate Student Seminar Series
Cr. R. Repeatable.
Presentation of professional topics by department graduate students. Development of presentation skills used in a professional conference setting involving question and answer format.

AER E 599: Creative Component
Cr. 1-5. Repeatable.

Courses for graduate students:

AER E 640: Stability of Fluid Flow
(3-0) Cr. 3.
Prereq: AerE 541
Theoretical methods of stability analysis; linear analysis of exchange of stability and over stability; bifurcation of equilibria; most dangerous modes and pattern formation; shear flow stability theorems. Physical mechanisms. Tollmein-Schlichting waves, disintegration of capillary jets, Benard convection, Taylor-Couette flow, centrifugal instability, double diffusion.

AER E 647: Advanced Computational Fluid Dynamics
(Cross-listed with M E). (3-0) Cr. 3. S.
Prereq: AER E 547

AER E 690: Aerospace Engineering Independent Study: Advanced Topics
Cr. 1-5. Repeatable.

AER E 690A: Aerospace Engineering Independent Study: Aero and/or Gas Dynamics
Cr. 1-5. Repeatable.

AER E 690B: Aerospace Engineering Independent Study: Propulsion
Cr. 1-5. Repeatable.
AER E 690C: Aerospace Engineering Independent Study: Aerospace Structures
Cr. 1-5. Repeatable.

AER E 690D: Aerospace Engineering Independent Study: Flight Dynamics
Cr. 1-5. Repeatable.

AER E 690E: Aerospace Engineering Independent Study: Spacecraft Systems
Cr. 1-5. Repeatable.

AER E 690F: Aerospace Engineering Independent Study: Flight Control Systems
Cr. 1-5. Repeatable.

AER E 690G: Aerospace Engineering Independent Study: Aeroelasticity
Cr. 1-5. Repeatable.

AER E 690H: Aerospace Engineering Independent Study: Viscous Aerodynamics
Cr. 1-5. Repeatable.

AER E 690I: Aerospace Engineering Independent Study: Design
Cr. 1-5. Repeatable.

AER E 690J: Aerospace Engineering Independent Study: Hypersonics
Cr. 1-5. Repeatable.

AER E 690K: Aerospace Engineering Independent Study: Computational Aerodynamics
Cr. 1-5. Repeatable.

AER E 690L: Aerospace Engineering Independent Study: Non Destructive Evaluation
Cr. 1-5. Repeatable.

AER E 690M: Aerospace Engineering Independent Study: Wind Engineering
Cr. 1-5. Repeatable.

AER E 697: Engineering Internship
Cr. R. Repeatable.

Prereq: Permission of DOGE (Director of Graduate Education), graduate classification
One semester and one summer maximum per academic year professional work period. Offered on a satisfactory-fail basis only.

AER E 699: Research
Cr. arr. Repeatable.