Course Catalog - Spring 2008

Aerospace Engineering

100 ***Intro to Aerospace Engineering*** credit: 1 hours.
Introduction to the Aerospace Engineering curriculum and career. Typical section topics include aircraft and rocket design and flight. Overviews of the topics are presented along with theory to be experimentally verified.

199 ***Undergraduate Open Seminar*** credit: 1 to 5 hours.

201 ***Aerospace Flight Mechanics I*** credit: 2 hours.
Fundamental principles of aerospace systems are introduced through a systems design approach. Aeronautical engineering topics of aerodynamics, propulsion, structures and flight mechanics, and astronautical engineering topics of orbital mechanics, rockets and spacecraft systems are presented. The principles are demonstrated through design projects. Prerequisite: Credit or concurrent registration in AE 252.

252 ***Aerospace Dynamics I*** credit: 2 hours.
Kinematics and dynamics of particle motion; methods of work-energy and impulse-momentum; kinematics of plane motion of rigid bodies; moving reference frames; moments of inertia. Credit is not given for both AE 252 and TAM 212. Prerequisite: TAM 210.

302 ***Aerospace Flight Mechanics II*** credit: 3 hours.
Introduction to the dynamics of aircraft and spacecraft and to orbital mechanics; aircraft performance in various flight attitudes; aircraft stability and control; spacecraft attitude dynamics and control; the two-body problem of orbital mechanics; orbit transfer. Prerequisite: AE 201 and AE 352.

311 ***Incompressible Flow*** credit: 3 hours.
Equations of motion for incompressible flow, both inviscid and viscous; potential flow theory, inviscid airfoil theory: two- and three-dimensional, Navier-Stokes equations, laminar boundary layer and transition to turbulence. Prerequisite: CS 101; credit or concurrent registration in MATH 241 or MATH 380.

312 ***Compressible Flow*** credit: 3 hours.
Compressible flow aerodynamics; conservation of mass, momentum, and energy; one-dimensional and quasi-one-dimensional flow; oblique shock waves and Prandtl-Meyer expansion waves; unsteady wave motion. Application to nozzles, diffusers, supersonic airfoils, and shock tubes. Prerequisite: AE 311, CS 101, MATH 285, ME 300; credit or concurrent registration in AE 201.

321 ***Aerospace Structures I*** credit: 3 hours.
Fundamental concepts in the linear theory of elasticity, including stress, strain, equilibrium, compatibility, material constitution and properties. Introduction to failure mechanisms and criteria. Application to plane stress/strain problems, beams in extension and bending, and shafts in torsion. Prerequisite: MATH 285 and TAM 210.

322 ***Aerospace Structures II*** credit: 3 hours.
Analysis of beams and shafts of monocoque and semi-monocoque construction. Energy methods. Theory of elastic stability with applications to buckling of columns. Introduction to finite element structural analysis - with application to trusses, frames, and plane stress/strain problems. Prerequisite: AE 321; CS 101; MATH 241 or MATH 380.

352 ***Aerospace Dynamics II*** credit: 3 hours.
Particle kinematics and dynamics; Lagrange's equations; vibration of multiple degree-of-freedom systems; rotational kinematics and dynamics of rigid bodies. Credit is not given for both AE 352 and TAM 412. Prerequisite: AE 252, MATH 225, and MATH 285.

353 ***Aerospace Control Systems*** credit: 3 hours.
Modeling of linear dynamic systems; Laplace transform techniques; linear feedback control systems; stability criteria; design techniques. Credit is not given for both AE 353 and either GE 320 or ME 340. Prerequisite: AE 252,

MATH 225, and MATH 285.

360 ***Structures & Control Lab*** credit: 2 hours.
Examines theory and application of experimental techniques in aerospace engineering with emphasis on structural mechanics, vibrations, dynamics, and control systems. Prerequisite: Credit or concurrent registration in AE 322, AE 352, and AE 353.

395 ***Honors Project*** credit: 1 to 4 hours.
Special aerospace engineering project or reading course for James Scholars in engineering. Prerequisite: Consent of instructor.

396 ***Honors Seminar*** credit: 1 to 4 hours.
Special lecture sequences and/or discussion groups arranged each term to bring James Scholars in engineering into direct contact with the various aspects of engineering practices and philosophy. Prerequisite: Consent of instructor.

397 ***Independent Study*** credit: 1 to 3 hours.
Independent theoretical and experimental projects in aerospace engineering. May be repeated. Prerequisite: Consent of instructor.

402 ***Orbital Mechanics*** credit: 3 or 4 hours.
Analysis of orbits in an inverse-square gravitational field; elementary rocket dynamics, impulsive orbit transfer and rendezvous, and Lambert's Theorem with applications; patched-conic trajectories, planetary gravity-assist maneuvers, and linearized orbit theory with application to simplified analytical models; perturbations. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 302.

403 ***Spacecraft Attitude Control*** credit: 3 or 4 hours.
Theory and applications of spacecraft attitude dynamics and control; Euler angles, direction cosines, quaternions, and Gibbs-Rodrigues parameters; attitude sensors and control actuators; spin, three-axis active, reaction wheel, control moment gyro, and gravity gradient control systems; environmental effects. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 352 and AE 353.

410 ***Computational Aerodynamics*** credit: 3 or 4 hours.
Introduction to computational technologies as solution tools for various aerodynamic problems; modeling and solution of one-and two-dimensional, incompressible and compressible, steady and unsteady inviscid external flow fields. Computational laboratory for practical experience. Same as CSE 461. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 311.

412 ***Viscous Flow & Heat Transfer*** credit: 4 hours.
Momentum and thermal transport in wall boundary-layer and free shear flows, solutions to the Navier-Stokes equations for heat conducting laminar and turbulent shear flows; similarity concepts; thermal boundary layers in ducts and high-speed aerodynamic boundary layers. Same as ME 411 and TAM 438. 4 undergraduate hours. 4 graduate hours. Prerequisite: AE 311 or ME 310.

413 ***Ideal Aerodynamics*** credit: 3 or 4 hours.
Governing equations for incompressible flow; vorticity, circulation, and Kelvin's and Helmholtz's theorems; velocity potential and stream function; three-dimensional steady and nonsteady flows, d'Alembert's paradox, and apparent mass; two-dimensional steady flows, complex potential and velocity, and mapping of flows; two-dimensional airfoils and Joukowski transformation and airfoils; thin airfoil theory. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 311.

416 ***Applied Aerodynamics*** credit: 3 or 4 hours.
Two-dimensional and finite wing theory with emphasis on the mechanisms of lift and drag generation; Reynolds number and Mach number effects; drag analysis; high-lift wing systems; propeller and rotor aerodynamics; control surface design; application of V/STOL aerodynamics. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 311.

419 ***Aircraft Flight Mechanics*** credit: 3 or 4 hours.
Steady and quasi-steady aircraft flight performance; take-off and landing, climbing and diving, cruise, level turn, and introduction to energy methods; longitudinal, directional, and lateral static stability and control; introduction to longitudinal and lateral motion and dynamic stability. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 302 and AE 353.

420 ***Finite Element Analysis*** credit: 3 or 4 hours.
Same as CSE 451 and ME 471. See ME 471.

427 ***Mechanics of Polymers*** credit: 3 hours.
Same as MSE 454 and TAM 427. See TAM 427.

428 ***Mechanics of Composites*** credit: 3 hours.
Same as MSE 456 and TAM 428. See TAM 428.

433 ***Aerospace Propulsion*** credit: 3 hours.
Fundamentals of rocket and airbreathing jet propulsion devices; prediction of thrust, combustion reactions, specific fuel consumption, and operating performance; ramjets; turbojets; turbofans; turboprops; aerothermodynamics of inlets, combustors, and nozzles; compressors, turbines; component matching. 3 undergraduate hours. Prerequisite: AE 312 and CS 101.

434 ***Rocket Propulsion*** credit: 3 or 4 hours.
Basic principles of chemical rocket propulsion and performance, propellants and their influence on design of rockets, internal ballistics, combustion processes, design of components, and flight performance. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 312 and AE 433.

435 ***Electric Propulsion*** credit: 3 or 4 hours.
Elements of propulsion as applied to deep space missions; physics of ionized gases; plasmadynamics; electrothermal, electromagnetic, and electrostatic acceleration of gases to high velocity; high-impulse thruster design and performance; the resistojet, arcjet, ion engine, MPD arc, and plasma gun. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 433.

440 ***Aerospace Systems Design I*** credit: 3 hours.
Introduction to the design of aerospace flight systems. Principles of systems engineering as they apply to the design process; general design methodology; application of these concepts to the initial sizing of both aircraft and spacecraft systems. Involves intensive technical writing. Involves intensive technical writing. AE 440 and AE 441 taken in sequence fulfill the Advanced Composition Requirement. 3 undergraduate hours. No graduate credit. Prerequisite: Credit or concurrent registration in AE 302, AE 311, AE 322, AE 352, and AE 433.
This course satisfies the General Education Criteria for a Advanced Composition course.

441 ***Aerospace Systems Design II*** credit: 3 hours.
Continuation of AE 440. Conceptual design project of either an aircraft or spacecraft flight system to satisfy a given set of requirements. Project team organization. Emphasis on sizing, trade studies and design optimization, subsystem integration, and technical communication skills. To fulfill the Advanced Composition Requirement, credit must be earned for both AE 440 and AE 441. 3 undergraduate hours. No graduate credit. Prerequisite: AE 440.
This course satisfies the General Education Criteria for a Advanced Composition course.

451 ***Aeroelasticity*** credit: 3 or 4 hours.
Advanced fundamental treatment of aerodynamic and dynamic structural phenomena associated with flexible airplanes and missiles; divergence of linear and nonlinear elastic lifting surfaces; effect of elastic and inelastic deformations on lift distributions and stability; elastic flutter of straight and swept wings; equations of disturbed motion of elastic and inelastic aircraft; dynamic response to forces, gusts, and continuous atmospheric turbulence; creep divergence of lifting surfaces; flutter in the presence of creep; effect of temperature on inelastic divergence and flutter. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: AE 352 or TAM 412; AE 322 or TAM 251.

460 ***Aerodynamics & Propulsion Lab*** credit: 2 hours.
Examines theory and application of experimental techniques in aerospace engineering with emphasis on fluid dynamic, aerodynamic, thermal, combustion, and propulsion phenomena. 2 undergraduate hours. No graduate credit. Prerequisite: AE 311; credit or concurrent registration in AE 433.

468 ***Optical Remote Sensing*** credit: 3 hours.
Same as ECE 468 and ATMS 468. See ECE 468.

470 ***Aerospace Numerical Methods*** credit: 3 hours.
Introduction to numerical methods used in aerospace engineering. Finite difference method; Variational principles and Rayleigh-Ritz method; finite element method; applications from simple structural mechanics and aerodynamics problems encountered in aerospace engineering. 3 undergraduate hours. No graduate credit. Prerequisite: CS 101, AE 311, AE 312, AE 321, and AE 322.

481 ***Wind Power Technology*** credit: 3 or 4 hours.
Aerodynamic, electromechanical, and structural design of wind power systems; classical windmills; modern wind power generators; wind characteristics and distribution; instrumentation and measurement; energy storage considerations; socioeconomics of wind power systems; performance of large and small scale wind turbines; current design approaches. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: A fluids course, an electrical course, and a course in mechanics, all at the 200 level or higher.

497 ***Independent Study*** credit: 1 to 4 hours.
Independent theoretical and experimental projects in aerospace engineering. Prerequisite: Consent of instructor.

498 ***Special Topics*** credit: 1 to 4 hours.
Special topics in Aerospace Engineering. May be repeated in the same or separate terms if topics vary to a maximum of 9 undergraduate hours or 12 graduate hours. Prerequisite: As specified for each topic offering; see Schedule or departmental course information.

502 ***Advanced Orbital Mechanics*** credit: 4 hours.
Circular restricted three body problem; surfaces of zero velocity, libration points, and halo orbits; perturbed two body motion; Gauss and Lagrange planetary equations, Hamilton's principle, canonical equations and Delaunay variables; application to artificial Earth satellites; orbit determination. Prerequisite: AE 402.

504 ***Optimal Aerospace Systems*** credit: 4 hours.
Formulation of parameter and functional optimization problems for dynamic systems; applications of optimization principles to the control and performance of aerospace vehicles, including optimal flight paths, trajectories, and feedback control. Prerequisite: AE 352.

508 ***Optimal Space Trajectories*** credit: 4 hours.
Optimal rocket trajectories in inverse-square and linearized gravitational fields; orbital transfer, intercept, and rendezvous; high-thrust (impulsive) and low-thrust (continuous) trajectories; primer vector theory and applications; cooperative rendezvous. Prerequisite: Credit or concurrent registration in AE 504.

511 ***Transonic Aerodynamics*** credit: 4 hours.
Fundamentals of transonic flows; transonic characteristics and flow modeling, shock wave development, properties of shock wave, transonic similarity, shock-boundary layer interactions, three-dimensional effects, transonic solution techniques, transonic design, and transonic testing. Prerequisite: ME 410.

513 ***Dispersed Multiphase Flow*** credit: 4 hours.
Basic overview of the physics, governing equations and numerical methods for dispersed multiphase flow 9also sometimes called particle suspensions), with particular emphasis on themomentum transfer to and from the particles. Characterization of particle size, shape, trajectories and coupling regimes; mixed-fluid, separated-fluid, and resolved-surface numerical approaches. Prerequisite: AE 412.

514 ***Boundary Layer Theory*** credit: 4 hours.

Theories of the boundary layer of a compressible fluid and their solutions, laminar and turbulent; boundary layer in hypersonic flows. Prerequisite: AE 412.

515 ***Wing Theory*** credit: 4 hours.
Theoretical analysis of the aerodynamic characteristics of two- and three-dimensional wings and multiple-body systems in subsonic and supersonic flows. Prerequisite: AE 413 or AE 416.

517 ***Fundamentals of Gas Kinetics*** credit: 4 hours.
Fundamental concepts required to study gas dynamic problems from the viewpoint of kinetic theory; derivation of the Boltzmann equation from classical mechanics; reduced and truncated distribution functions and the BBGKY hierarchy; molecular collisions; flux vectors and equations of change; moment equations; summational invariants; H-theorem and Maxwellian distribution; inclusion of the effect of solid surfaces in kinetic theory; existence theory for the Boltzmann equation; iteration procedures; moment methods; Chapman-Enskog procedure; first and second approximations to the distribution function, heat flux vector, and stress tensor. Prerequisite: ME 410 and AE 412.

518 ***Theory of Rarefied Gas Flow*** credit: 4 hours.
Application of kinetic theory to rarefied gas flow problems; free-molecule flow; near free-molecule flow; linearized problems; flows with appreciable deviation from equilibrium. Prerequisite: AE 517.

525 ***Advanced Composite Materials*** credit: 4 hours.
An extension of AE 428/TAM 428. Advanced analysis of composite materials. Anisotropic elasticity; micromechanical theories; behavior of composite plates and beams under bending, buckling, and vibration; advanced elasticity solution techniques; hygrothermal behavior of polymer composites; strength prediction theories and failure mechanisms in composites; processing of metal, ceramic, and polymer composites; analysis of residual stresses. Same as TAM 525. Prerequisite: AE 428.

526 ***Composites Manufacturing*** credit: 4 hours.
Review of the manufacturing methods for polymer-matrix composite materials; analysis of fiber processing techniques, interfacial treatments, and composites fabrication methods; analytical treatment of process modeling including heat transfer, cure kinetics, resin flow, and residual stresses. A term project is required. Same as ME 555 and TAM 526. Prerequisite: TAM 428/AE 428.

528 ***Nonlinear Continuous Media*** credit: 4 hours.
Fundamental concepts of large deformations in nonlinear elasticity and inelasticity with applications: generalized tensors, finite deformations, stress-strain relations in terms of strain energy functions, solutions of tension, shear and bending problems, finite plane strain, theory of successive approximations, fiber-reinforced beams, plates and cylinders, thermodynamics of deformable media, stability considerations, and constituent relations for inelasticity. Prerequisite: TAM 428/AE 428.

529 ***Viscoelasticity Theory*** credit: 4 hours.
Fundamental concepts of viscoelasticity with applications: elastic-viscoelastic analogies, creep and relaxation functions, thermomechanical reciprocity relations, variational principles, model fitting, shear center motion, thick-walled cylinders under pressure and inertia loads with material annihilation, sandwich plates, propagation of viscoelastic waves, vibration of bars, plates and shells, nonlinear elastic-viscoelastic analogy, properties of nonlinear viscoelastic stress-strain laws, creep rupture, and torsion of nonlinear bars and shells. Same as TAM 529. Prerequisite: TAM 428/AE 428.

538 ***Combustion Fundamentals*** credit: 4 hours.
Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. Same as ME 501. Prerequisite: AE 311 or ME 410.

552 ***Stochastic Structural Dynamics*** credit: 4 hours.
Structural dynamics problems treated from a probabilistic point of view; theory of probability and random processes introduced as mathematical tools; response of structures under random excitation is studied in order of increasing complexity; probability of failure for such structures. Same as TAM 517. Prerequisite: AE 352 or TAM 412.

554 ***Dynamical Systems Theory*** credit: 4 hours.
Fundamental concepts of nonlinear oscillations, structural stability, local and global bifurcations in the context of ordinary and partial differential equations; introduction to dynamic systems, structural stability and Lyapunov-Schmidt Reduction, bifurcations of equilibrium points, limit cycles and tori, the center manifold and Poincare normal forms, co-dimension two and higher order bifurcations, bifurcation theory of maps, the Birkhoff-Smale homoclinic theorem and horseshoes, Melnikov's method and Silnikov phenomena, period doubling, and other routes to chaos. Applications to many engineering problems, such as aircraft at high angles of attack, pipes conveying fluid, and panel flutter will be demonstrated. Prerequisite: AE 352 or TAM 412.

555 ***Multivariable Control Design*** credit: 4 hours.
Frequency response design-specifications; algebraic and analytic constraints in scalar systems; uncertainty representation; Nyquist stability theory, small gain condition, and multi-input multi-output systems; singular value decomposition; robustness and u-function; linear quadratic regulator based design; recovery of LQ Design properties; Kalman filter; Riccati equations; H-infinity based design; reduction; balanced truncation; Hankel singular values; coprime factor reduction; loop shaping. Same as GE 521. Prerequisite: ECE 515.

556 ***Robust Control*** credit: 4 hours.
Signal and system spaces; stability, robustness, and the small gain theorem; factorization and parameterization of all stabilizing controllers; performance and achievable closed loop maps; model matching; design of optimal single-input single-output systems in H-infinity, H2, L1 senses; extensions to multi-output systems; structured and unstructured uncertainty; robust performance analysis and synthesis; multi-objective control. Prerequisite: ECE 515 and MATH 446.

590 ***Seminar*** credit: 0 hours.
Presentation by graduate students, staff, and guest lecturers of current topics in aerospace engineering. Approved for S/U grading only.

597 ***Independent Study*** credit: 1 to 4 hours.
Independent theoretical and experimental projects in aerospace engineering. Prerequisite: Consent of instructor.

598 ***Special Topics*** credit: 1 to 4 hours.
Special topics in Aerospace Engineering. May be repeated in the same or separate terms if topics vary to a maximum of 12 hours. Prerequisite: As specified for each topic offering; see Schedule or departmental course information.

599 ***Thesis Research*** credit: 0 to 16 hours.
Research in the various areas of aerospace engineering. Approved for S/U grading only. May be repeated.