Mechanical and Aerospace Engineering

N274 Technology Hall
Telephone: 256.824.6154
Email: maegrad@uah.edu

Chair: D. Keith Hollingsworth, Professor

Mission

The mission of the Department of Mechanical and Aerospace Engineering is to provide undergraduate and graduate education, research, and public service in the Mechanical and Aerospace Engineering disciplines and to support the Mechanical and Aerospace Engineering needs of Huntsville, the State of Alabama, the region, our nation, and the international community.

Degree Programs

- Master of Science in Engineering (Mechanical Engineering)
- Master of Science in Aerospace Systems Engineering
- Doctor of Philosophy in Mechanical Engineering
- Doctor of Philosophy in Aerospace Systems Engineering

The broad range of faculty research interests in the Department of Mechanical and Aerospace Engineering offers opportunities for advanced work in rocket propulsion, combustion, applications of plasma science, fluid and solid mechanics, heat transfer, acoustics, aerodynamics, transport phenomena in energy systems, computational mechanics, experimental mechanics, dynamics and controls, and autonomous vehicles.

Located in one of the nation's leading centers for aviation and space research, UAH has the intellectual and social environment to provide a well-rounded, technologically-oriented degree. MAE graduate students have outstanding opportunities for research, collaboration, cooperative employment, and future employment with government research centers and high-tech businesses. In addition, a number of UAH research centers collaborate with the MAE Department, including the Propulsion Research Center, the Center for Rotor craft Systems Engineering and Simulation, the Center for Modeling, Simulation & Analysis, the Center for Space Plasma and Aeronomic Research, the Center for Applied Optics, and the Nano and Micro Devices Center.

Prospective and current students are encouraged to visit the MAE Department web site at www.uah.edu/eng/departments/mae for information about faculty research interests, ongoing research projects, funding opportunities and course availability. Other information about the MAE graduate programs are available in the department office.

MS in Aerospace Systems Engineering or MSE in Mechanical Engineering

Students wishing to pursue an MAE master's degree must meet the admission requirements of the UAH Graduate School as well as the College of Engineering. Students who are admitted to the MAE department master's program have the option to enroll in the MS in Aerospace Systems Engineering or the MSE in Mechanical Engineering. All courses in the department are open to students in either option. A beginning student files a Program of Study in one of the specialized areas of concentration (e.g. aerodynamics, materials, solid mechanics, etc). These selections are made in consultation with the faculty advisor (for students in the thesis program) or with the Graduate Director (for students in the non-thesis program). Each area of concentration may have other requirements.

The MS in Aerospace Systems Engineering and the MSE in Mechanical Engineering each require 31 semester hours and consist of two options. The thesis option requires 24 hours of graduate coursework, 1 hour of graduate seminar, and 6 hours of thesis. Students under this option must complete a written thesis and an oral defense. The non-thesis option requires 30 hours of graduate coursework and 1 hour of graduate seminar.

PhD in Aerospace Systems Engineering or in Mechanical Engineering

The MAE Department offers a program leading to the degree of Doctor of Philosophy (PhD) in Aerospace Systems Engineering or in Mechanical Engineering. The PhD is a research-oriented degree awarded upon completion of a defined Program of Study, demonstration of scholarly competence, distinctive achievement in a special field, and demonstrated ability to do an independent, original investigation. Demonstration of substantial scholarly research accomplishments, rather than mere accumulation of residence and course credits, is an essential consideration in awarding the PhD degree. A Program of Study leading to a PhD degree in Chemical Engineering is also administered by the MAE Department. In addition to the admission requirements of the School of Graduate Studies and the College of Engineering for the MSE, students must also have a minimum graduate grade point average of 3.25 for an application to be processed. Specific admission requirements for students with an MSE degree from UAH or from another graduate institution are available by contacting the MAE department office.

The PhD Program of Study should exhibit both a breadth of understanding of engineering with a demonstrated depth in a focused area of Aerospace or Mechanical Engineering. The MAE Ph.D. Program of Study consists of a minimum of 67 course and research semester hours beyond the B.S.E. degree. The course semester hour requirement for students with a M.S.E. degree is a minimum of 48 semester hours, that is, a minimum of 18 semester hours beyond the MSE degree. The specific Ph.D. Program of Study is designed by the student, his/her advisor, and the Supervisory Committee. In addition

to the coursework required, a PhD student must pass three examinations before being awarded the degree; the Preliminary Examination, the Qualifying Examination, and the Final Comprehensive Examination. Specific details on each examination are provided in the MAE Department Office.

Details about these degree options can be found at http://catalog.uah.edu/grad/colleges-departments/engineering/mechanical-aerospace-engineering/#text .

Timing Requirements (Effective Fall Semester 2016)
Students who are pursuing a Ph.D. degree are subject to the following four timing requirements:

1. Part I of the Qualifying Examination (i.e., MAE Ph.D. Prelim Exam) must be completed successfully either within **one year** from the start of the Ph.D. degree program or prior to the completion of **12 credit hours of graduate course work** (whichever comes later).
2. A Ph.D. Dissertation Advisor and Ph.D. Supervisory Committee must be arranged and approved within **one year** of the successful completion of Part I of the Qualifying Examination.
3. Part II of the Qualifying Examination must be completed successfully within **two years** of the successful completion of Part I of the Qualifying Examination but **no less than six months** prior to the Dissertation Defense.
4. All Ph.D. degree requirements must be completed successfully within **five years** of the successful completion of Part II of the Qualifying Examination.

Exceptions to any of these requirements may be requested only one time (per each requirement) by petition from the student and the associated Ph.D. Dissertation Advisor. Approval of these petitions (including modifications or alterations) are made both by the MAE Department Graduate Committee and by the MAE Department Chair.

Master's Programs in Mechanical and Aerospace Engineering

- Aerospace Systems Engineering, MSASE (http://catalog.uah.edu/grad/colleges-departments/engineering/mechanical-aerospace-engineering/aerospace-systems-engineering)
- Mechanical Engineering, MSE (http://catalog.uah.edu/grad/colleges-departments/engineering/mechanical-aerospace-engineering/mechanical-engineering-mse)

Doctoral Programs in Mechanical and Aerospace Engineering

- Aerospace Systems Engineering, PhD (http://catalog.uah.edu/grad/colleges-departments/engineering/mechanical-aerospace-engineering/asephd)
- Mechanical Engineering, PhD (http://catalog.uah.edu/grad/colleges-departments/engineering/mechanical-aerospace-engineering/mechanical-engineering-phd)

MAE 520 - COMPRESSIBLE AERODYNAMICS
Semester Hours: 3

Principles of compressible flow including area change, friction, and heat transfer. Fundamentals of acoustic waves, one and two-dimensional shock and expansion waves, shock-expansion theory, and linearized flow with applications to inlets, nozzles, wind tunnels, and supersonic flow over aerodynamic bodies and wings. (Same as MAE 420.).

MAE 530 - FUNDAMENTALS OF AERODYNAMICS
Semester Hours: 3

Application of the principles of fluid mechanics and thermodynamics to the prediction of aerodynamic performance of aircraft, missiles and other flight vehicles. Topics include lift and drag, thrust and power, and the influence of wing loading, power loading, zero-lift drag, wing geometry, high lift devices Mach number, etc., on the performance and design trades of flight vehicles. (Same as MAE 430.).

MAE 531 - INTRO TO PLASMA DYNAMICS
Semester Hours: 3

MAE 540 - ROCKET PROPULSION I
Semester Hours: 3

Introduction to the operation, analysis and design of liquid and solid rockets. The course incorporates an experience in design and realization of a thermal system in which students work in teams to design a rocket motor or component.

MAE 541 - AIRBREATHING PROPULSION
Semester Hours: 3

Survey of airbreathing propulsion systems with special emphasis on gas turbine engines for aircraft and rotorcraft. Thermodynamic power cycles, design of components, and overall engine performance analysis. Discussion of practical design and operations considerations including engine controls, reliability, and durability. The course incorporates an experience in design and realization of a thermal system in which students work in teams to design a turbine engine. Students majoring in Aerospace Engineering must take either MAE 440 or MAE 441 to satisfy the Aerospace propulsion elective.

MAE 544 - INTRO TO ELECTRIC PROPULSION
Semester Hours: 3

Elements of electrically-driven rocket propulsion for applications from low earth orbit to the outer planets. The physics of ionizing and heating gases and plasmas for electrothermal, electrostatic and electromagnetic acceleration. Characteristics of Resistojet, Arcjet, Magnetoplasmadynamic thrusters, Electrothermal, Pulsed plasma, Electrostatic, and Hall thrusters. Review thruster system performance, power requirements, and selection for space missions. Overview of current research efforts, including thruster systems, physics, and performance.

MAE 545 - HEAT DISTRIB SYS DESIGN
Semester Hours: 3

Design of hydronic and air distribution systems used in heating and air conditioning. Piping design, pump selection, heat coils, room air distribution, ducting design, fan selection, controls, and complete systems.

MAE 548 - ENERGY CONVERSION & POWER GEN
Semester Hours: 3

Application of principles of thermodynamics, heat transfer, and fluid mechanics to combustion engines and turbines. Basic engine types, engine components, idealized cycles, combustion, fuels, engine variables, testing, exhaust gas analysis, and air pollution as related to spark-ignition, compression-ignition, and turbine engines.

MAE 552 - COMPRESSIBLE AERODYNAMICS
Semester Hours: 3

Principles of compressible flow including area change, friction, and heat transfer. Fundamentals of acoustic waves, one and two-dimensional shock and expansion waves, shock-expansion theory, and linearized flow with applications to inlets, nozzles, wind tunnels, and supersonic flow over aerodynamic bodies and wings.

MAE 561 - VIBRATIONS ELASTIC SYS
Semester Hours: 3

Formulation of the equations of motion of discrete and continuous systems, analytical and numerical methods of solution, eigenvalue problems, and dynamic response. (Same as MAE 461 and CE 461/561.).

MAE 563 - INTERMEDIATE DYNAMICS
Semester Hours: 3

Kinematics and dynamics of particles, system of particles, and rigid-bodies. Variational principles and Lagrangian mechanics.

MAE 568 - ELEMENTS OF SPACECRAFT DESIGN
Semester Hours: 3

Fundamentals of spacecraft engineering and design. Topics include: orbital mechanics, space environment, attitude determination and control, communications, space structures, thermal control, propulsion and power, and systems and mission design. (Same as MAE 468.).

MAE 574 - APP MECHANICS OF SOLIDS
Semester Hours: 3

Stresses and strains at a point, theories of failures, stress concentration factors, thick-walled cylinders, torsion of noncircular members, curved beams, unsymmetrical bending, and shear center. (Same as MAE 474 and CE 474/574.).

MAE 576 - COMP MATLS: FABRIC/DES/ANALY
Semester Hours: 3

Introduction to the mechanics of advanced composite materials. Design and analysis of composite structures. Analysis of orthotropic and transversely isotropic materials and systems. Hands on fabrication of a composite structure. (Same as MAE 476.).

MAE 577 - EXP TECH SOLID MECHANICS
Semester Hours: 3

Experimental methods to determine stress, strain, displacement, velocity, and acceleration in various media. Theory and laboratory applications of electrical resistance strain gages, brittle coatings, and photoelasticity. Application of transducers and experimental analysis of engineering systems. (Same as MAE 477 and CE 477/577.).

MAE 580 - AIRCRAFT STABILITY & CONTROL
Semester Hours: 3

Stability and control of aerodynamic vehicles. Design of aircraft to obtain good flying characteristics. Complete governing equations and analog solutions of linearized equations. (Same as MAE 480.).

MAE 585 - NUM METH & ENGR COMPUTAT III
Semester Hours: 3

Advanced topics in numerical methods and engineering computation including: finite elements and finite differences in solving various engineering problems; Gaussian quadrature; interpolation, integration, and differentiation; and stability and convergence analysis of iterative methods. Numerical applications to fluid mechanics, heat transfer, structural mechanics, and machine design.

MAE 589 - COMPUTER AIDED ENGR
Semester Hours: 3

Application of computer methods in the analysis and design of structural, thermal, and dynamical systems. Use of state-of-the-art finite element and finite difference computer programs. Practical guidelines for discrete modeling; analysis of modeling errors. Comparison of exact and approximate solutions to boundary value problems. Use of microcomputers in engineering design and analysis. (Same as MAE 489.).

MAE 593 - ROCKET DESIGN
Semester Hours: 3

Design, build, test and fly a high-powered rocket with a payload to a specified altitude. Students work on multi-disciplinary teams to design payloads, avionics, recovery systems, structures and other sub-systems and then integrate them into the final vehicle. Course may be used for senior design credit.

MAE 594 - AIRCRAFT DESIGN
Semester Hours: 3

Design and build an unmanned aircraft to meet specified requirements, and then verify design through ground and flight tests. Students work on multi-disciplinary teams to address configuration aerodynamics, avionics, structures, proplusion/power and payloads. Systems engineering aspects including simulation, fabrication, integration, scheduling and cost estimation are also emphasized. Course may be used for senior design credit.

MAE 595 - SELECTED TOPICS MECH & AERO EG
Semester Hours: 1-6

MAE 610 - AERODYNAMICS
Semester Hours: 3

Fundamental concepts in aerodynamics including conservation laws, complez potential theory, thin airfoil theories, finite-wing lifting-line theory, boundary layers and Von Karman momentum integral equations.

MAE 620 - COMPRESSIBLE FLOW
Semester Hours: 3

Study of compressible subsonic, transonic and supersonic flows as described by the Euler equations. Linear and nonlinear theories of shockwaves, expansion waves, and their interactions. Applications to wind tunnels, nozzles, diffusers and aerodynamic bodies.

MAE 623 - COMPUTATIONAL FLUID DYNAMICS I
Semester Hours: 3

Formulations by finite difference, finite element, finite volume, and spectral element methods for incompressible and compressible flows. Explicit and implicit methods, Von Neumann error analysis, consistency, convergence, and accuracy.

MAE 631 - ROTORCRAFT DESIGN I
Semester Hours: 3

Conceptual design of rotorcraft systems with an emphasis on multidisciplinary design. Comprehensive methodologies for vehicle synthesis and sizing including consideration of aerodynamics, propulsion, materials and structures, flight performance and control, and operations. Integration of advanced technologies. Rotocraft Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Rotocraft Systems Engineering.

MAE 632 - ROTORCRAFT DESIGN II
Semester Hours: 3

Continuation of Rotorcraft Design I including higher fidelity simulations and trade studies. Consideration of maneuverability, structural dynamics, drive train and hub design, advanced flight control system design, sensors, weapons, component integration, packaging, and life-cycle cost. Rotorcraft Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Rotorcraft Systems Engineering.

MAE 633 - TACTICAL MISSILE DESIGN I
Semester Hours: 3

Conceptual design of missile systems with an emphasis on multi-disciplinary design. Comprehensive methodologies for vehicle synthesis and sizing including consideration of aerodynamics, propulsion, materials and structures, flight performance and control, and operations. Integration of advanced technologies. Tactical Missile Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Missile Systems Engineering.

MAE 634 - TACTICAL MISSILE DESIGN II
Semester Hours: 3

Continuation of Tactical Missile Design I including higher fidelity simulations and trade studies. Consideration of trajectory modeling and simulation, open-loop flight control system design, sensors, component integration and packaging, and life-cycle cost. Tactical Missile Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Missile Systems Engineering.

MAE 635 - AEROSPACE SYSTEMS ENGINEERING
Semester Hours: 3

Introduction to Integrated Product and Process Development (IPPD) and life cycle analysis with application to Aerospace Systems. Systems engineering and quality engineering methods and tools. Top-down design decision support process. Computer integrated environment and robust design simulation will be addressed.

MAE 639 - SYSTEM SAFETY
Semester Hours: 3

The process of system safety?from the creation and management of a safety program on a system under development to the analysis that must be performed as this system is designed and produced to assure acceptable risk in its operation. Full discussion of the management and analysis processes and procedures. Incorporates the safety procedures used by the Department of Defense and NASA. Basic statistical methods and network analysis methods which provide an understanding of the engineering analysis methods that follow are covered.

MAE 640 - ROCKET PROPULSION II
Semester Hours: 3

MAE 641 - ADV THERMODYNAMICS
Semester Hours: 3

Application of classical thermodynamics. Treatment of problems involving nonideal gases and liquids, phase equilibrium, and chemical equilibrium. (Same as CHE 641.).

MAE 643 - ADVANCED HEAT & MASS TRANSFER
Semester Hours: 3

Continuation of MAE 450 in the study of conductive, convective, and radiative heat transfer and mass transfer. Emphasis is placed on heat transfer in turbulent flows and high speed flows, combined mode heat transfer, and mass transfer in reacting flows.

MAE 644 - ADVCD SOLID ROCKET PROPUL
Semester Hours: 3

Overview of the design, manufacture and testing of solid rocket propulsion systems. Specific topics include propellant ballistics and combustion, grain design, motor case and nozzle design, thermal protection, motor performance, and reliability and failure. Prerequisite: MAE 540.

MAE 645 - COMBUSTION I
Semester Hours: 3

Combustion chemistry, introduction to mass transfer, chemical kinetics, reactors, simplified governing equations for chemically reacting flow, laminar diffusion and premixed flames.

MAE 646 - COMBUSTION I
Semester Hours: 3

Combustion chemistry, introduction to mass transfer, chemical kinetics, reactors, simplified governing equations for chemically reacting flow, laminar diffusion and premixed flames.

MAE 647 - UNCERTAINTY ANAL IN EXPER
Semester Hours: 3

Uncertainty analysis concepts and techniques; application in planning, design, construction, debugging, execution, data analysis and reporting phases of experimental programs. Discussion of national and international standards and current engineering uncertainty analysis literature.

MAE 649 - TRANSPORT PHENOMENA
Semester Hours: 3

Mass, energy, and momentum transport in steady and transient motions in real and rheological substances. (Same as CHE 649.).

MAE 651 - VISCOUS FLUID MECHANICS
Semester Hours: 3

Fundamentals of incompressible viscous fluid motion, including development of Navier Stokes equation. Exact and approximate solutions for both large and small Reynolds number. Laminar and turbulent boundary layers.

MAE 657 - HELICOPTER THEORY
Semester Hours: 3

Vertical flight, forward flight, performance, design, mathematics of rotating systems, rotary wing dynamics, rotary wing aerodynamics, helicopter aeroelasticity, stability and control, stall, and noise.

MAE 658 - ROTORDYNAMICS
Semester Hours: 3

Torsional and transverse rotor vibration, critical speed and stability analysis, response to unbalance, rotor balancing. Rotordynamic phenomena including: gyroscopic effects, fluid film bearings, annular seals, stiffness asymmetry.

MAE 660 - STRUCTURAL DYNAMICS
Semester Hours: 3

Application of the theory of vibrations to discrete and continuous models of structures. Numerical methods of analysis for both spatial and temporal variables. Modal synthesis and step-by-step time integration methods. Finite element applications; substructuring techniques. (Same as CE 660.).

MAE 661 - ADVANCED DYNAMICS
Semester Hours: 3

Variational methods, optimization, and dynamic stability. Lagrangian and Hamiltonian formulation for dynamical systems and Hamilton-Jacobi methods to orbital mechanics.

MAE 662 - NONLINEAR DYNAM & CHAOS
Semester Hours: 3

Nonlinear and chaotic dynamical systems, phase plane, periodic and strange attractors, stability analysis, critical points, Piapunov exponents, bifurcation points, solitons, logistic maps, Poincare and Henon iterative maps, factals, Mandelbrot and Julia sets, chaos in complex dynamical systems.

MAE 663 - ASTRODYNAMICS
Semester Hours: 3

Astronomical coordinates and time systems; the many-body problems and disturbing functions. General perturbation methods, and application of classical mechanics and Hamilton-Jacobi methods to orbital mechanics.

MAE 671 - CONTINUUM MECHANICS
Semester Hours: 3

Kinematics and kinetics, various coordinate systems, constitutive equations for continuous media; governing partial differential equations from first and second laws of thermodynamics; applications to solids, liquids, and gases. (Same as CE 671.).

MAE 672 - ELASTICITY
Semester Hours: 3

Formulation of boundary-value problems of classical elasticity. Application to plane problems, prismatic members, and axisymmetric problems. Introduction to three-dimensional problems. (Same as CE 672.).

MAE 673 - PLASTICITY
Semester Hours: 3

Fundamentals of mechanical behavior of metals and nonmetals for stress states greater than the yield stress state. Deformation and flow theories. Stress-strain relations and yield criteria. Solution of boundary value problems with plastic bodies. Limit analysis of structures. (Same as CE 673.).

MAE 674 - FINITE ELEMENT ANALYS I
Semester Hours: 3

Finite element theory, variational methods, weighted residuals; applications to linear partial differential equations in continuous media; solution of boundary-value and initial-value problems. (Same as CE 674.).

MAE 676 - VISCOELASTICITY
Semester Hours: 3

Mechanical behavior of materials having time-dependent and temperature-dependent material properties. Creep and relaxation phenomena. Elastic-viscoelastic analogies. Formulation of stressstrain laws. Solution of boundary value problems for viscoelastic bodies. (Same as CE 676.).

MAE 677 - OPTICAL TECH IN SOLID MECH
Semester Hours: 3

Overview of conventional methods for experimental stress analysis. Introduction to applied optics with emphasis on non-destructive, laser-based testing methods, fiber optic recording systems,photoelectronic-numerical data acquisition, and computer aided analysis. (Same as CE 677.).

MAE 678 - MECH COMPOSITE MATERIALS
Semester Hours: 3

Introduction to composite materials, micro- and macro-mechanical behavior of laminae; bending, buckling and vibration of laminated plates. (Same as CE 678.).

MAE 680 - PERFORMANCE FLIGHT TESTING
Semester Hours: 3

Fundamentals of rotorcraft test and evaluation. Topics include: test planning, requirements analysis, helicopter performance evaluation, fundamentals of propulsion testing, aviation safety, use of modeling and simulation in flight testing, Department of Defense and Federal Aviation Administration requirements and procedures.

MAE 681 - MISSILE TRAJECTORY ANALYSIS
Semester Hours: 3

Methods for generating trajectories of missiles and projectiles are studied as well as control mechanisms. Point mass approximations are developed using approximations and exact representations of drag and atmospheric conditions Full six degree-of-freedoms models are developed and solved numerically. Aerodynamic models are developed for both slowly spinning missiles and spin stabilized projectiles. Projectile linear theory is developed and used to discuss gyroscopic and dynamic stability and introduce rapid trajectory generation.

MAE 683 - GRAD SEMINAR MECH ENGR
Semester Hour: 1

Professional activities designed to promote the skills required to organize and deliver oral technical presentations and to broaden the individual's awareness of technical issues. Required for all students pursuing a graduate degree. Students will be graded 'S' (satisfactory) or 'U' (unsatisfactory) based upon their performance and attendance. Students who do not receive an 'S' grade must register for the course until an 'S' is obtained.

MAE 684 - AEROSPACE SYSTEMS SEMINAR
Semester Hour: 1

Seminar course for students in the MSE (Aerospace) Rotorcraft Systems Engineering and Missile Systems Engineering programs of study. students participate in seminars on specific aspects of rotorcraft and missile systems engineering including system integration, modeling and simulation, operations, and advanced technologies.

MAE 692 - GRAD ENGR ANALYSIS I
Semester Hours: 3

Ordinary differential equations (ODEs), Bessel functions, Legendre polynomials, Laplace transformations, simultaneous differential equations, application of ODEs to mechanical systems, partial differential equations (PDEs) and boundary-value problems, application of PDEs to mechanical systems.

MAE 693 - GRAD ENGR ANALYSIS II
Semester Hours: 3

Green's functions, Fourier series and integrals, linear algebra, vectors, vector analysis and integral theorems, introduction to tensor analysis, analytical functions of a complex variable, Taylor and Laurent expansions, the residue theorem, stability criteria, and Calculus of Variations.

MAE 695 - SELECTED TOPICS MECH & AERO EG
Semester Hours: 1-9

MAE 696 - GRAD INTERN MECH & AERO ENGR
Semester Hours: 1-9

Active involvement in an engineering project in an engineering enterprise, professional organization, or government agency that has particular interest and relevance to the graduate student. Permission of MAE faculty member required.

MAE 698 - PLAN II MASTER'S PAPER
Semester Hours: 3

Required Plan II paper for a Plan II Masters degree. Completion of 18 semester hours of graduate course work required.

MAE 699 - MASTER'S THESIS
Semester Hours: 1-9

Required each semester in which a student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of 9 hours of credit is awarded upon successful completion of master's thesis. Requires thesis advisor permission. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.

MAE 723 - COMPUTATIONAL FLUID DYNA II
Semester Hours: 3

Continuation of Computational Fluid Dynamics I, advanced topics in finite difference, finite element, finite volume, and spectral element methods.

MAE 724 - COMPUTATIONAL FLUID DYNAMI III
Semester Hours: 3

Grid generation techniques with structured and unstructured meshes, adaptive meshes, domain decompositions, and parallel processing. Applications of generated meshes to any one of the following problems: turbulence, combustion, acoustics, radiation, multiphase flows, or magnetohydrodynamics.

MAE 726 - ROTORCRAFT COMPUT FLUID DYNA
Semester Hours: 3

Full potential, Euler, Navier-Stokes approaches, structural and unstructured grids, wake capturing, turbulence, and acoustics.

MAE 740 - AEROTHERMODYNAMICS
Semester Hours: 3

Description of the dynamic and thermal fluid flow environments associated with hypervelocity vehicles and propulsion systems with emphasis on thermochemical nonequilibrium behavior. Topics include thermostatistical basis for internal energies, specific heats and shock strengths in dissociated and ionized gases; formulation of reacting flow conservation equations; and recent experimental advances in aerothermodynamics.

MAE 741 - STATIS THERMODYNAMICS
Semester Hours: 3

Statistical ensembles; Maxwell-Boltzmann, Bose, Einstein, and Fermi-Dirac statistics. Application of statistical mechanics to thermodynamic processes. Information theory and its formalism.

MAE 745 - COMBUSTION II
Semester Hours: 3

Droplet evaporation and burning, introduction to turbulent flow, turbulent diffusion and premixed flames, burning of solids, pollutant emissions, and detonation.

MAE 746 - CONVECTIVE HEAT TRANSFER
Semester Hours: 3

Advanced theory of convective transport processes in fluids, including transport of momentum and energy in laminar flow, boundary layers and turbulent transport in shear flow. Engineering applications include boiling and two phase processes.

MAE 748 - RADIATIVE TRANSFER
Semester Hours: 3

Physics and modeling of radiative transfer. Scattering, remote sensing, and absorption in participating media. Infrared through optical wave lengths. Computational methods in radiative transfer.

MAE 749 - MASS TRANSPORT
Semester Hours: 3

Mass transfer in solid and fluid systems under steady and transient conditions. Integration of momentum, heat and mass transfer equations with application to reactive, rheological and multicomponent systems.

MAE 751 - BOUNDARY LAYER THEORY
Semester Hours: 3

Development of boundary layers using singular perturbation theory. Curvature and compressible effects and the order of their importance. Modern applications and computational approaches.

MAE 752 - MECH OF RARIFIED GASES
Semester Hours: 3

Application of kinetic theory to rarefied gas-flow problems. Boltzmann statistical distribution; gas-surface interaction, transport properties, free molecule flow; heat-free molecule flow; procedures for non-equilibrium flows. Offered upon demand.

MAE 753 - MAGNETO-GAS DYNAMICS
Semester Hours: 3

Equations of motion for ionized gases with critical analysis of transport properties in steady and varying electric and magnetic fields. MHD shock waves and radiation effects.

MAE 754 - HYPERSONIC FLOW
Semester Hours: 3

Theories for treating the laminar and turbulent boundary layers of reacting fluids, mixtures, related chemical, thermodynamic, and physical phenomena in hypersonic flows. Leading edge bluntness, shock wave interactions, and vorticity effects.

MAE 755 - ADVANCED AERODYNAMICS
Semester Hours: 3

Transonic, supersonic, and hypersonic flows. Application of compressible potential theory, similarity rules, slender body theory and Newtonian flow theory to the analysis of aerodynamics of aircraft, missiles, re-entry vehicles, and other flight vehicles.

MAE 756 - NUM SIM OF MAGNETOHYDRODYNAMIC
Semester Hours: 3

Finite difference methods for simulation of MHD flows. Methods include explicit scheme, FICE methods, LBL, ADI, artificial damping and projected characteristics for multidimensional timedependent flow.

MAE 757 - OPT TECH/FLUID MECHANICS
Semester Hours: 3

Laser sources, molecular interactions with light and diatomic spectroscopy needed fluorescence, Brillouin scattering, four wave mixing, CARS and other applications in optical fluid diagnostics. (Same as CHE 757.).

MAE 758 - TURBULENCE
Semester Hours: 3

Turbulence in gases and liquids; boundary layers, atmospheric phenomena.

MAE 760 - ANALY METH NONLIN DYNAM
Semester Hours: 3

Application of averaging methods and perturbation methods to vibrations of nonlinear systems. Analysis of linear systems with periodic coefficients (Floquet theory). Elements of stability theory, Liapunov functions, and Liapunov?s direct method.

MAE 762 - WAVE MOT/CONT ELAS BODIES
Semester Hours: 3

Elements of stress wave propagation in bounded elastic media. Propagation of elastic waves in infinite and semi-infinite bodies, cylinders, rods and beams. (Same as CE 762.).

MAE 765 - RANDOM VIBR/ELASTIC SYSTEMS
Semester Hours: 3

Dynamic analysis of elastic systems including the response of complex structures to random excitations. Typical excitations include random wind, thermal, earthquake, aerodynamic, and ocean wave phenomena. Probabilistic mechanics methods. Concepts of reliability. Stationary and ergodic processes.

MAE 768 - DYN AEROSPACE VEHICLES
Semester Hours: 3

Elements of advanced rotational kinematics of rigid bodies. Attitude motion of space vehicles in circular and elliptic orbits. Methods of gravitation and spin stabilization of gyrostat.

MAE 772 - THEORY STRUCT STABILITY
Semester Hours: 3

Energy criterion for stability of elastic structure under conservative loading. Stability concept for general continuous systems. Rigorous and approximate methods of analysis. Buckling of structural elements under impulsive and nonconservative loading. Postbuckling behavior.

MAE 773 - THEORY OF SHELLS
Semester Hours: 3

Analysis of thin plates and shells including higher order approximation theories and transverseshear deformations. Illustration of theories by selected problems. (Same as CE 773.).

MAE 774 - FINITE ELEM ANALY II
Semester Hours: 3

Advanced topics in finite element analysis; application to nonlinear partial differential equations in continuum mechanics; theoretical studies of convergence and stability of solutions. (Same as CE 774.).

MAE 776 - TH FIN ELAST FIN VISCOEL
Semester Hours: 3

Theory of finite deformation analysis for elastic and viscoelastic materials. Constitute models are developed for a functional analysis approach leading to models based on the Cauchy-Green Deformation Tensor and the Strain Energy Density Function. Models discussed include: Mooney-Rivlin and Bernstein-Kearsley-Zappas.

MAE 778 - FRACTURE MECHANICS
Semester Hours: 3

Theory of crack propagation, stress intensity factors, mapping techniques, series expansion, asymptotic approximations, field singularities, integral transforms, numerical solutions. (Same as CE 778.).

MAE 780 - THEORY OF ACOUSTICS
Semester Hours: 3

Simple harmonic oscillators, damped and forced oscillators, 1-D wave equation, vibration of a string, 2-D wave equation, vibration of membranes, the acoustic wave equation, plane waves, cylindrical and spherical waves, reflection and transmission, radiation and reception of acoustic waves, absorption and attenuation of sound, cavities and wave guides, and architectural acoustics.

MAE 781 - NONLINEAR EFFECTS/PLASMA
Semester Hours: 3

Fundamental physical concepts and methods of estimating various nonlinear interactions in plasmas. Analytical and numerical methods to deal with these problems.

MAE 782 - PLASMA TURBULENCE
Semester Hours: 3

Methodology that deals with plasma turbulence together with current numerical techniques to solve these problems approximately, via super-computing.

MAE 795 - SELECTED TOPICS MECH & AERO EG
Semester Hours: 1-9

MAE 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9

Required each semester student is enrolled and receiving direction on doctoral dissertation.