AEROSPACE ENGINEERING

The aerospace engineering program in the department of mechanical and aerospace engineering offers comprehensive graduate education in a number of areas. Aerodynamics, gas dynamics, hypersonics, aerospace system design, aerospace propulsion, aerospace structures, plasma aerospace applications, multidisciplinary optimization, and flight dynamics and control are the major areas of emphasis. A wide variety of interdisciplinary programs meeting specific objectives are available. The aerospace engineering program offers the master of science and doctor of philosophy degrees. The department also offers several graduate certificate programs in both aerospace engineering and mechanical engineering. Details of certificate programs can be found under the mechanical engineering program listing.

Typical examples of research activities are: analysis and design of composite structures, structural acoustics, aeroacoustics, smart structures, active and passive vibration control, optimization of systems based on structural dynamics or structural performance, astrodynamics, guidance and control of aircraft and missiles, robust multivariable control, microsatellite design, fabrication, and test, neural network architecture for control, estimation theory, real-time flight simulation, non-equilibrium shock wave structure, propulsion research with emphasis on how fuel variables influence combustion, atomization of liquid fuels in supersonic flow, flame stability in combustion systems, scramjet and supersonic combustion scramjet studies, computational fluid dynamics, laser interaction problems, free turbulent mixing, unsteady high angle of attack flow configurations, computer simulation of separated flows, low-speed and high-speed aerodynamics, aerodynamics of high-lift devices, aerospace system design, and viscous effects in transonic flows.

The mechanical and aerospace engineering department has many well equipped laboratories located on the main campus, and a subsonic-flow laboratory in an off-campus facility. Some of the specially equipped laboratories on campus include: a supersonic-flow laboratory with a Mach 4 blow-down wind tunnel, a hot-wire anemometer system, a Schlieren system; an airflow test facility; an acoustics and vibration laboratory; a laser diagnostics laboratory equipped with state-of-the-art lasers to conduct experiments related to aerodynamics and combustion; a composite materials testing laboratory with state-of-the-art material testing system; low velocity impact facility and high speed photography equipment; and extensive computer facilities including a personal computer laboratory, advanced computer graphics laboratory, computer learning center with engineering work stations. The flight simulator program at Missouri S&T incorporates a fixed-base real-time flight simulator without-the-window display.

The master of science thesis program consists of a minimum of 30 credit hours, including the following requirements: at least 21 credit hours of lecture courses, at least 6 credit hours of MECH ENG 6099, at least 9 credit hours of lecture courses in the MAE department (of which at least 3 credit hours must be at the 6000-level), at least 3 credit hours of mathematics, statistics, or computer science (AERO ENG 5830 Applied Compt Methods may be used to satisfy this requirement), and at least 6 credit hours of 6000-level lecture courses. A master of science non-thesis program consists of a minimum of 30 credit hours, including the following requirements: at least 24 credit hours in the MAE department and at least 9 credit hours of 6000-level lecture courses (of which at least 6 credit hours must be in the MAE department). Note that no course below the 5000-level may be applied to the degree requirements.

A student holding an M.S. degree and pursuing the doctor of philosophy degree must complete at least 42 total credit hours, including the following requirements: at least 18 credit hours of lecture courses, at least 24 credit hours of MECH ENG 6099, at least 12 credit hours of course work in the MAE department, at least 3 credit hours of mathematics, statistics, or computer science (AERO ENG 5830 Applied Computational Methods may be used to satisfy this requirement), and at least 9 credit hours of 6000-level courses (of which at least 6 credit hours must be in the MAE department). In addition to these course requirements, a candidate must prepare a dissertation based on analytical, numerical, and/or experimental research. Note that no course below the 5000-level level may be applied to the degree requirements.

A student holding a B.S. degree and pursuing the direct doctor of philosophy degree must complete at least 72 total credit hours, including the following requirements: at least 36 credit hours of lecture courses, at least 36 credit hours of MECH ENG 6099, at least 21 credit hours of course work in the MAE department, at least 6 credit hours of mathematics, statistics, or computer science (AERO ENG 5830 Applied Computational Methods may be used to satisfy three credit hours of this requirement), and at least 15 credit hours of 6000-level courses (of which at least 9 credit hours must be in the MAE department). In addition to these course requirements, a candidate must prepare a dissertation based on analytical, numerical, and/or experimental research. Note that no course below the 5000-level level may be applied to the degree requirements.

A candidate for the degree of doctor of philosophy must pass a qualifying examination. The candidate is considered to have passed the qualifying examination if the candidate has taken at least four courses and has a GPA ≥ 3.5 at the end of the candidate's fourth semester. At least two courses must be in the MAE department, one of which must be at the 6000-level.

Richard Billo, Director of the Kummer Institute Center for Advanced Manufacturing, Distinguished Professor of Mechanical and Aerospace Engineering
PHD Arizona State University

Victor Birman, Emeritus Professor
PHD Technion, Haifa, Israel
Composite material structures, smart structures.

K Chandrashekhara, Curators Distinguished Professor
PHD Virginia Polytechnic Institute
Composite materials, smart structures, structural dynamics, finite element analysis, composite manufacturing and experimental characterization.

L R Dharani, Curators Distinguished Professor
PHD Clemson University
Micromechanics of bi-material interfaces, composite materials, fracture mechanics, fatigue and failure analysis of welded structures, wear and friction in composites, fracture and failure of laminated glass.

Xiaosong Du, Assistant Professor
PHD Iowa State University
Machine learning, deep learning, rapid aerodynamic forward/inverse/robust design, single-/multi-fidelity predictive modeling, analysis and decision making under uncertainty.

Daoru Han, Associate Professor
PHD University of Southern California
Plasma aerospace applications; space propulsion; plasma-material interactions; plasma physics and rarefied gas dynamics; highperformance computing.

Serhat Hosder, Professor
PHD Virginia Polytechnic Institute
Computational fluid dynamics, aerodynamics, multidisciplinary design and optimization, uncertainty and error quantification in computational simulations, robust design, micro/nano flows, hypersonic flows, numerical methods.

K M Isaac, Professor Emeritus
PHD Virginia Polytechnic Institute
Fluid dynamics and combustion, aero-structure interaction and control, intelligent aircraft, active flow control, wave-riders, microfluidics, MEMS, flow and combustion in porous media, multiphase flow, emissions from combustion and evaporative systems, lean premixed combustion, combustion instability, active combustion control, atomization and sprays, particle image velocimetry (PIV) and CFD applications in fluid dynamics and combustion problems.

Henry J Pernicka, Curators' Distinguished Teaching Professor
PHD Purdue University
Astrodynamics, orbital mechanics, spacecraft design, spacecraft mission design, satellite attitude dynamics, nonlinear analysis, dynamics and control, optimization.

David W Riggins, Curators Distinguished Teaching Professor Emeritus
PHD Virginia Polytechnic Institute
Fluid dynamics, computational fluid dynamics, hyper/sonic propulsion systems, computational analysis of jet mixing, flow losses and mixing enhancement in combustors, aircraft gas turbine scramjet propulsion systems, and scramjet performance.

Davide Vigano, Assistant Professor
PHD University of Texas at Arlington
Hypersonic air-breathing propulsion, injection mixing and in high speed flows, compressible turbulent mixing, vortex dynamics, hypersonic aerothermodynamics, experimental fluid dynamics, instrumentation development, Arc-Jet testing.

AERO ENG 5000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

AERO ENG 5001 Special Topics (LEC 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title. (Co-listed with Mech Eng 5001).

AERO ENG 5131 Intermediate Thermofluid Mechanics (LEC 3.0)
Derivation of Navier-Stokes equations, analytical solutions of viscous flows; flow in pipes, flow networks; intermediate treatment of boundary layer theory; micro-fluidics and MEMS; introduction to numerical methods for solving fluid flows; and, preliminary treatise on turbulence. Prerequisite: Mech Eng 3131 or Aero Eng 3131. (Co-listed with Mech Eng 5131).

AERO ENG 5139 Computational Fluid Dynamics (LEC 3.0)
Introduction to the numerical solution of the Navier-Stokes equations, by finite difference methods, in both stream function-vorticity and primitive variable formulations. Course format emphasizes student development of complete computer programs utilizing a variety of solution methods. Prerequisites: Comp Sci 1570 or 1970 or 1971; one course in fluid mechanics. (Co-listed with Mech Eng 5139).

AERO ENG 5169 Introduction to Hypersonic Flow (LEC 3.0)
A study of the basic principles of hypersonic flow. Invisvid and viscous hypersonic flow. Application of numerical methods. High temperature flow. Consideration of real gas and rarefied flow. Applications in aero-dynamic heating and atmospheric entry. Prerequisites: Aero Eng 3171.

AERO ENG 5171 V/Stol Aerodynamics (LEC 3.0)
Basic concepts of V/STOL flight. Take-off transition and landing performance, thrust vectoring. Propeller and helicopter aerodynamics. Unblown and blown flaps. Boundary layer control. Lift fans and ducted propellers. Wing-propeller interaction and thrust augmentation. Prerequisite: Aero Eng 3171.

AERO ENG 5212 Introduction to Finite Element Analysis (LEC 3.0)
Variational formulation of the governing equations. Finite element model, interpolation functions, numerical integration, assembly of elements and solution procedures. Applications to solid mechanics, fluid mechanics and heat transfer problems. Two-dimensional problems. Computer implementation and use of commercial finite element codes. Prerequisites: Math 3304; senior or graduate standing. (Co-listed with Mech Eng 5212).

AERO ENG 5229 Smart Materials and Sensors (LAB 1.0 and LEC 2.0)
Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multi-disciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior standing and Math 3304. (Co-listed with Mech Eng 5229, Elec Eng 5270 and Civ Eng 5118).

AERO ENG 5234 Stability of Engineering Structures (LEC 3.0)
Solution of stability problems with applications to columns, plates and shell structures. Torsional and lateral buckling of columns. Buckling under high temperatures. Effect of imperfections introduced by a technological process on stability. Design issues related to stability requirements. Prerequisites: Civ Eng 2210; Math 3304; and Mech Eng 2350 or Mech Eng 2360 or Aero Eng 2360. (Co-listed with Mech Eng 5234).

AERO ENG 5236 Fracture Mechanics (LEC 3.0)
Linear elastic and plastic mathematical models for stresses around cracks; concept of stress intensity; strain energy release rates; correlation of models with experiment; determination of plane stress and plane strain parameters; application to design. Prerequisite: Civ Eng 2210. (Co-listed with Mech Eng 5236).

AERO ENG 5238 Fatigue Analysis (LEC 3.0)
The mechanism of fatigue, fatigue strength of metals, fracture mechanics, influence of stress conditions on fatigue strength, stress concentrations, surface treatment effects, corrosion fatigue and fretting corrosion, fatigue of joints components and structures, design to prevent fatigue. Prerequisite: Civ Eng 2210. (Co-listed with Mech Eng 5238).

AERO ENG 5282 Introduction to Composite Materials & Structures (LEC 3.0)
Introduction to fiber-reinforced composite materials and structures with emphasis on analysis and design. Composite micromechanics, lamination theory and failure criteria. Design procedures for structures made of composite materials. An overview of fabrication and experimental characterization. Prerequisite: Civ Eng 2210. (Co-listed with Mech Eng 5282).

AERO ENG 5307 Vibrations I (LEC 3.0)
Equations of motion, free and forced vibration of single degree of freedom systems. Natural frequencies, resonance, modes of vibration and energy dissipation are studied. The vibration of continuous systems is introduced. Prerequisites: Mech Eng 3411 and 3313, or Aero Eng 3613 and Math 3304. (Co-listed with Mech Eng 5307).

AERO ENG 5309 Engineering Acoustics I (LEC 3.0)
Introduction to acoustical theory and measurement with emphasis on mechanical and aerospace engineering applications. Plane and spherical wave propagation, resonators and filters, absorption, room acoustics, human response to noise, noise legislation, noise control. Use of common instrumentation in several projects. Prerequisites: Mech Eng 3411 & 3313, or Aero Eng 3613 & Math 3304. (Co-listed with Mech Eng 5309).

AERO ENG 5313 Intermediate Dynamics of Mechanical and Aerospace Systems (LEC 3.0)
Principles of dynamics are applied to problems in the design of mechanical and aerospace systems; basic concepts in kinematics and dynamics; dynamics of systems of particles; dynamics of rigid bodies, three-dimensional effects in machine elements; dynamic stability, theory and applications; methods of analytical dynamics. Prerequisite: Mech Eng 3313 or Aero Eng 3613. (Co-listed with Mech Eng 5313).

AERO ENG 5353 Aeroelasticity (LEC 3.0)
Study of phenomena involving interactions among inertial, aerodynamic, and elastic forces and the influence of these interactions on aircraft and space vehicle design. Some aeroelastic phenomena are: divergence, control effectiveness, control reversal, flutter, buffeting, dynamic response to rapidly applied loads, aeroelastic effects on load distribution, and static and dynamic stability. Prerequisites: Aero Eng 3251 and 3171.

AERO ENG 5361 Flight Dynamics-Stability And Control (LEC 3.0)
Review of static stability, dynamic equations of motion, linearized solutions, classical control design and analysis techniques, introduction to modern control. Prerequisite: Aero Eng 3361.

AERO ENG 5449 Robotic Manipulators and Mechanisms (LAB 1.0 and LEC 2.0)
Overview of industrial applications, manipulator systems and geometry. Manipulator kinematics; hand location, velocity and acceleration. Basic formulation of manipulator dynamics and control. Introduction to machine vision. Projects include robot programming, vision-aided inspection and guidance, and system integration. Prerequisites: Mech Eng 3313; Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972 or Comp Sci 1570. (Co-listed with Mech Eng 5449).

AERO ENG 5478 Mechatronics (LAB 1.0 and LEC 2.0)
This course will introduce students to the basics of mechatronics (i.e., the integration of mechanical, electrical, computer, and control systems). Students will learn the fundamentals of sensors and actuators for mechanical systems, computer interfacing, microcontrollers, real-time software, and control. Prerequisite: Mech Eng 4479 or equivalent. (Co-listed with Mech Eng 5478, Elec Eng 5870 and Comp Eng 5820).

AERO ENG 5479 Machine Learning for Manufacturing Automation (LEC 3.0)
Principles of machine learning, machine learning techniques (support vector machines, regression analysis, recurrent and convolution neural networks, autoencoders, deep reinforcement learning), applications (anomaly detection, computer vision, robotics). Prerequisites: Mech Eng 4479 or Mech Eng 5313 or Aero Eng 3361 or Aero Eng 5313; and Comp Sci 1972. (Co-listed with Aero Eng 5479).

AERO ENG 5481 Mechanical and Aerospace Control Systems (LEC 3.0)
Synthesis of mechanical and aerospace systems to perform specific control functions. Response and stability are studied. Singular value analysis for stability margins is introduced. Prerequisite: Mech Eng 4479 or Aero Eng 3361. (Co-listed with Mech Eng 5481).

AERO ENG 5519 Advanced Thermodynamics (LEC 3.0)
After a short review of classical thermodynamics, the elements of chemical reactions, chemical equilibrium, statistical thermodynamics, and the basic concepts of kinetic theory are presented. Prerequisite: Mech Eng 2519. (Co-listed with Mech Eng 5519).

AERO ENG 5525 Intermediate Heat Transfer (LEC 3.0)
Analytical study of conduction; theory of thermal radiation and applications; energy and momentum equations in convective heat transfer and review of empirical relations. Current topics are included. Prerequisite: Mech Eng 3525. (Co-listed with Mech Eng 5525).

AERO ENG 5527 Combustion Processes (LEC 3.0)
Application of chemical, thermodynamic, and gas dynamic principles to the combustion of solid, liquid, and gaseous fuels. Includes stoichiometry, thermochemistry, reaction mechanism, reaction velocity, temperature levels, and combustion waves. Prerequisite: Mech Eng 3521. (Co-listed with Mech Eng 5527).

AERO ENG 5535 Aerospace Propulsion Systems (LEC 3.0)
Study of atmospheric and space propulsion systems with emphasis on topics of particular current interest. Mission analysis in space as it affects the propulsion system. Power generation in space including direct and indirect energy conversion schemes. Prerequisite: Aero Eng 4535.

AERO ENG 5539 Modeling Across Scales in Computational Mechanics (LEC 3.0)
Fundamental principles of continuum and sub-continuum (atomic) models will be learned through lectures and hands-on Matlab coding. Prerequisites: Civ Eng 2210, Mech Eng 2519, or consent of instructor for majors that do not require either of these courses; or graduate standing. (Co-listed with Mech Eng 5539).

AERO ENG 5570 Plasma Physics I (LEC 3.0)
Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Mech Eng 5570, Nuc Eng 4370, Physics 4543).

AERO ENG 5614 Spaceflight Mechanics (LEC 3.0)
Further topics in orbital mechanics. Time equations, Lambert's problem, patched-conic method, orbital maneuvers, orbit determination, orbit design, re-entry problem. Prerequisite: Aero Eng 3613.

AERO ENG 5715 Concurrent Engineering (LEC 3.0)
Students will be introduced to the concurrent engineering approach to product development. They will learn to set up quantitative requirements and then use a quantitative rating process to identify the critical requirements relating to the desired product. The interaction between design, manufacturing, assembly, cost, and supportability will be covered. The students will form teams and practice the concurrent engineering process for simple products. Prerequisites: Mech Eng 3313 or Aero Eng 3131 and Civ Eng 2210 (Co-listed with Mech Eng 5715).

AERO ENG 5760 Probabilistic Engineering Design (LEC 3.0)
The course deals with uncertainties in engineering analysis and design at three levels - uncertainty modeling, uncertainty analysis, and design under uncertainty. It covers physics-based reliability analysis and reliability-based design, robustness assessment and robust design, their integration with design simulations, and their engineering applications. Prerequisite: Mech Eng 3708 or Aero Eng 3361. (Co-listed with Mech Eng 5760).

AERO ENG 5830 Applied Computational Methods (LEC 3.0)
Detailed study of computational methods for efficient solution of selected fluids, structures, thermodynamics, and controls problems in aerospace and mechanical engineering. Besides basic numerical techniques, topics covered include gradient-based optimization and uncertainty quantification. Prerequisite: Comp Sci 1570 or 1970 or 1981; Math 3304. (Co-listed with Mech Eng 5830).

AERO ENG 6000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects of projects in the department. Consent of instructor required.

AERO ENG 6001 Special Topics (LEC 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title. (Co-listed with Mech Eng 5001).

AERO ENG 6010 Seminar (LEC 0.0-1.0)
Discussion of current topics. (Co-listed with Mech Eng 6010).

AERO ENG 6040 Oral Examination (IND 0.0)
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/ comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

AERO ENG 6050 Continuous Registration (IND 1.0)
Doctoral candidates who have completed all requirements for the degree except the dissertation, and are away from the campus must continue to enroll for at least one hour of credit each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

AERO ENG 6099 Research (IND 0.0-15)
Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

AERO ENG 6123 Viscous Fluid Flow (LEC 3.0)
Fundamentals of viscous fluids for incompressible and compressible flows governed by Navier-Stokes equations; exact, approximate, and numerical solutions for steady and unsteady laminar flows; boundary layer theory for incompressible and compressible flows; stability and transition. Prerequisite: Mech Eng 5131 or Aero Eng 5131 or Mech Eng 5139 or Aero Eng 5139 or equivalent. (Co-listed with Mech Eng 6123).

AERO ENG 6131 Gas Dynamics I (LEC 3.0)
A critical analysis of the phenomena governing the flow of a compressible fluid; introduction to flow in two and three dimensions; Prandtl-Meyer expansions; small perturbations in subsonic and supersonic flows; method of characteristics. Prerequisite: Mech Eng or Aero Eng 5131. (Co-listed with Mech Eng 6131).

AERO ENG 6135 Turbulent Flows - Theory, Measurements and Modeling (LEC 3.0)
Navier-Stokes equations; statistical description and mean-flow equations; behavior of free shear and wall bounded flows; the energy cascade; turbulence spectra and Kolmogorov hypothesis; measurement techniques: PIV, hot-wires, LDV; turbulence modeling for transport processes and closure schemes for RANS equations; evaluation of model constants, introduction to LES, DNS and hybrid-RANS. Prerequisite: Mech Eng 5131 or Aero Eng 5131 or Mech Eng 5139 or Aero Eng 5139 or equivalent. (Co-listed with Mech Eng 6135).

AERO ENG 6137 Physical Gas Dynamics I (LEC 3.0)
Features of high temperature gas flows including the development of the necessary background from kinetic theory, statistical mechanics, chemical thermodynamics and chemical kinetics. Equilibrium and Nonequilibrium gas properties and gas flows are included. Prerequisite: Mech Eng 5131 or Aero Eng 5131. (Co-listed with Mech Eng 6137).

AERO ENG 6212 Advanced Finite Element Analysis (LEC 3.0)
Higher order, isoparametric and mixed finite elements. Eigenvalue and time-dependent problems. Solution procedures for dynamic analysis. Implicit and explicit methods. Applications to viscous incompressible fluid and plate bending problems. Three-dimensional problems. Nonlinear finite element analysis. Practical applications using commercial software. Prerequisite: Mech Eng 5212 or Aero Eng 5212. (Co-listed with Mech Eng 6212).

AERO ENG 6222 Theory of Elasticity (LEC 3.0)
Formulation and study of boundary-value problems in 2-D linear elastostatics: Equilibrium and compatibility. Stress function formulations in Cartesian and polar coordinates. Curved beam, wedge and plane contact problems. Dislocations and cracks. Thermoelasticity. Prerequisites: Civ Eng 2210. (Co-listed with Mech Eng 6222).

AERO ENG 6284 Analysis of Laminated Composite Structures (LEC 3.0)
An overview of isotropic beams, plates, and shells. Bending, vibration, and buckling of laminated composite beams and plates: exact and approximate solutions. Development of composite shell theory and simplified solutions. Analysis of composite structures including transverse shear deformation and thermal effects. Prerequisite: Mech Eng 5282 or Aero Eng 5282. (Co-listed with Mech Eng 6284).

AERO ENG 6307 Advanced Vibrations (LEC 3.0)
Advanced treatment of discrete and continuous vibratory systems. Extensive use is made of matrix methods and operator notation. Special topics include: transmission matrices, relative coordinates, time dependent boundary conditions, approximate techniques for linear systems, nonlinear systems and random excitations. Prerequisite: Mech Eng or Aero Eng 5307. (Co-listed with Mech Eng 6307).

AERO ENG 6410 Optimal Control and Estimation (LEC 3.0)
Review of linear quadratic regulators, LQR extensions; constrained optimization (Pontragin's minimum principle); review of probability theory and random processes; optimal prediction and filters; frequency domain properties of LQR and Kalman filters; linear quadratic Gaussian (LQG) control; model uncertainties, frequency shaping, LQG/LTR design methodology. Prerequisites: Elec Eng 6300 or Mech Eng 5481 or Aero Eng 5481. (Co-listed with Elec Eng 6310 and Mech Eng 6410).

AERO ENG 6430 Robust Control Systems (LEC 3.0)
Performance and robustness of multivariable systems, linear fractional transformations, LQG/LTR advanced loop shaping, Youla parameterization, H (subscript infinity) optimal control, mixed H (subscript 2) and H (subscript infinity) control, controller synthesis for multiple objective optimal control, linear matrix inequalities theory and case studies. Prerequisites: Elec Eng 6300 or Mech Eng 5481 or Aero Eng 5481. (Co-listed with Mech Eng 6430 and Elec Eng 6330).

AERO ENG 6447 Markov Decision Processes (LEC 3.0)
Introduction to Markov Decision Processes and Dynamic Programming. Application to Inventory Control and other optimization and control topics. Prerequisite: Graduate standing in background of probability or statistics. (Co-listed with Comp Eng 6310, Mech Eng 6447, Eng Mgt 6410, Sys Eng 6217 and Comp Sci 6202).

AERO ENG 6458 Adaptive Dynamic Programming (LEC 3.0)
Review of Neurocontrol and Optimization, Introduction to Approximate Dynamic Programming (ADP), Reinforcement Learning (RL), Combined Concepts of ADP and RL - Heuristic Dynamic Programming (HDP), Dual Heuristic Programming (DHP), Global Dual Heuristic Programming (GDHP), and Case Studies. Prerequisites: Elec Eng 5370 or Comp Eng 5310. (Co-listed with Comp Eng 6320, Elec Eng 6360, Mech Eng 6458 and Sys Eng 6215).

AERO ENG 6479 Analysis And Synthesis Of Mechanical And Aerospace Systems (LEC 3.0)
A unified treatment of modern system theory for the Mechanical and Aerospace Engineering Controls Analyst, including analysis and synthesis of linear and nonlinear systems, compensation and optimization of continuous and discrete systems, and theory of adaptivity. Prerequisite: Mech Eng 5481 or Aero Eng 5481. (Co-listed with Mech Eng 6479).

AERO ENG 6481 Advanced Topics in Decision and Control (LEC 3.0)
This course will deal with latest topics in the areas of decision and control. Course may be repeated if topics vary. Prerequisites: Aero Eng 5481 or Mech Eng 5481 or equivalent. (Co-listed with Mech Eng 6481).

AERO ENG 6527 Heat Transfer by Convection (LEC 3.0)
An analytical study of convective heat transfer in laminar and turbulent flows; forced convection, natural convection, and mixed convection; combined heat and mass transfer; heat transfer with change of phase; instability of laminar flow; current topics in convection. Prerequisite: Mech Eng 5525 or Aero Eng 5525. (Co-listed with Mech Eng 6527).

AERO ENG 6614 Advanced Astrodynamics (LEC 3.0)
Analysis of spacecraft motion using different dynamic models and perturbations. Using the state transition matrix and differential corrections technique for trajectory computation. Introduction to the three-body problem. Use of computational and numerical methods to solve astrodynamic problems. Prerequisite: Aero Eng 5614.

AERO ENG 6657 Laser Aided Manufacturing And Materials Processing (LEC 3.0)
Fundamental studies in laser aided manufacturing and materials processing including laser principles and optics, physics of laser-materials interaction, interface responses for rapid solidification, theories on non-equilibrium synthesis, modeling of transport phenomena, optical sensing techniques, current topics and considerations for lasers in manufacturing. Prerequisite: Mech Eng 5519. (Co-listed with Mech Eng 6657).
