MECHANICAL AND AEROSPACE ENGINEERING

BME 5580 Introduction to Microfluidics and BioMEMS 3 Credits
Grading Scheme: Letter Grade
Introduction to concepts of miniaturization, materials and methods for microfabrication, principles of microfluidics, and biological applications of microfluidic devices and biomedical microelectromechanical systems.
Prerequisite: EGN 3353C or equivalent.

EAS 5242 Mechanics of Composite Materials 3 Credits
Grading Scheme: Letter Grade
Micro- and macro-mechanics, thermo-mechanical analysis and failure theories for composite materials. Design and analysis of composite structural elements.

EAS 5938 Special Topics in Aerospace Engineering 1-4 Credits, Max 8 Credits
Grading Scheme: Letter Grade
Special Topics in Aerospace Engineering

EAS 6138 Gasdynamics 3 Credits
Grading Scheme: Letter Grade
Theory of sound waves, subsonic and supersonic flows, shockwaves, explosions and implosions.
Prerequisite: EAS 4132 or EML 5714 or equivalent.

EAS 6242 Advanced Structural Composites 3 Credits
Grading Scheme: Letter Grade
Micro- and macro-behavior of a lamina. Stress transfer of short fiber composites. Classical lamination theory, static analysis of laminated plates, free-edge effect, failure modes.
Prerequisite: EGM 3520.

EAS 6403 Spacecraft Attitude Dynamics 3 Credits
Grading Scheme: Letter Grade
Rigorous development of theoretical concepts, analytical, mathematical procedures, and methods associated with defining, determining, and controlling the attitude of a spacecraft.
Prerequisite: Undergraduate vector calculus, programming (python or MATLAB), and dynamics courses together with an undergraduate linear algebra or numerical methods course.

EAS 6413C Spacecraft Attitude Estimation and Control 3 Credits
Grading Scheme: Letter Grade
Sensors and actuators used in spacecraft attitude navigation and control, how to process data from sensors, and how to command actuators. Kalman and extended Kalman filtering, control methods based on momentum exchange devices (reaction wheels, control moment gyroscopes), and thrusters.
Prerequisite: (EAS 4510 or EAS 6939) and EML 5215, with minimum grades of B.

EAS 6415 Guidance and Control of Aerospace Vehicles 3 Credits
Grading Scheme: Letter Grade
Applying modern control theory to aerospace vehicles. Parameter identification methods applied to aircraft and missiles.
Prerequisite: EAS 4412 or equivalent.

EAS 6416 Robust and Adaptive Control for Aerospace Systems 3 Credits
Grading Scheme: Letter Grade
Modern robust, optimal, and adaptive control theories that address flight control challenges for aerospace systems. Topics include robust servomechanism design, linear quadratic methods, optimal observer-based feedback, loop transfer recovery, multivariable frequency domain analysis, and guidance fundamentals.
Prerequisite: Undergraduate courses in Linear Algebra & Differential Equations & Linear Controls & Programming in MATLAB.

EAS 6511 Intermediate Astrodynamics 3 Credits
Grading Scheme: Letter Grade
Rigorous analysis of spacecraft motion using different dynamic models and perturbation methods. Development of analytical and computational tools to solve problems in astrodynamics.
Prerequisite: EML 5215 or equivalent graduate-level dynamics course.

EAS 6905 Individual Projects in Aerospace Engineering 1-3 Credits, Max 9 Credits
Grading Scheme: Letter Grade
Individual Projects in Aerospace Engineering

EAS 6910 Supervised Research 1-5 Credits
Grading Scheme: S/U

EAS 6939 Special Topics in Aerospace Engineering 1-6 Credits, Max 15 Credits
Grading Scheme: Letter Grade
Laboratory, lectures, or conferences covering selected topics in space engineering.

EAS 6940 Supervised Teaching 1-3 Credits, Max 5 Credits
Grading Scheme: S/U
Provides students with supervised teaching experience on developing effective instructional methods and materials in engineering education as well as effective mentoring skills in a professional setting.
Prerequisite: ARO_PHD.

EAS 6971 Research for Master's Thesis 1-15 Credits
Grading Scheme: S/U
Research for Master's Thesis

EAS 7979 Advanced Research 1-12 Credits
Grading Scheme: S/U
Research for doctoral students before admission to candidacy. Designed for students with a master's degree in the field of study or for students who have been accepted for a doctoral program. Not appropriate for students who have been admitted to candidacy.

EAS 7980 Research for Doctoral Dissertation 1-15 Credits
Grading Scheme: S/U
Research for Doctoral Dissertation

EGM 5111L Experimental Stress Analysis 3 Credits
Grading Scheme: Letter Grade
Introduction to techniques of experimental stress analysis in static systems. Lecture and laboratory include applications of electrical resistance strain gauges, photoelasticity, brittle coatings, moire fringe analysis, and X-ray stress analysis.
Prerequisite: EGM 3520.

EGM 5121C Data Measurement and Analysis 3 Credits
Grading Scheme: Letter Grade
Tools for random data analysis (including types of random data, mean values, mean-square values, probability density and distribution functions, moments and characteristic functions, and spectral and correlation analysis); bias and random error estimates in data measurements; input-output system models; and measurement examples.

EGM 5423 High Strain Rate Behavior of Materials 3 Credits
Grading Scheme: Letter Grade
Dynamic behavior of materials, comparison of material response between quasistatic and extremely high strain rates, deformation mechanisms, microstructural evolution at high strain rate, dynamic fracture, constitutive modeling, mechanical properties.
Prerequisite: EGM3520 or equivalent

EGM 5533 Applied Elasticity and Advanced Mechanics of Solids 3 Credits
Grading Scheme: Letter Grade
Bars, beams, thin-walled structures, and simple continua in the elastic and inelastic range. Virtual work approaches, elastic energy principles, plastic limit theorems, and creep deformation procedures. Introduction to instability and fracture mechanics. Design applications.
Prerequisite: EGM 3520.

EGM 5584 Biomechanics of Soft Tissue 3 Credits
Grading Scheme: Letter Grade
Introduction to solid and fluid mechanics of biological systems. Rheological behavior of materials subjected to static and dynamic loading. Mechanics of cardiovascular, pulmonary, and renal systems. Mathematical models and analytical techniques used in biosciences.
Prerequisite: EGN 3353C and EGM 3520.

EGM 5586 Modeling and Control of Biomolecular Machines 3 Credits
Grading Scheme: Letter Grade
Overview of biomolecular systems engineering. Introduction to cell processes, biochemical kinetics, models of biological macromolecules, analyses of biomolecular dynamics, simulation of stochastic behaviors, common gene regulatory network motifs, and the design of synthetic biology circuits.
Prerequisite: MAP 2302 with a minimum grade of C.

EGM 5816 Intermediate Fluid Dynamics 3 Credits
Grading Scheme: Letter Grade
Basic laws of fluid dynamics. Introduction to potential flow, viscous flow, boundary layer theory, and turbulence.
Prerequisite: A proficiency in Fluid Mechanics and Differential equations is needed.

EGM 6321 Principles of Engineering Analysis I 3 Credits
Grading Scheme: Letter Grade
Solution of linear and nonlinear ordinary differential equations. Methods of Frobenius, classification of singularities. Integral representation of solutions. Treatment of the Bessel, Hermite, Legendre, hypergeometric, and Mathieu equations. Asymptotic methods including the WBK and saddle point techniques. Treatment of nonlinear autonomous equations. Phase plane trajectories and limit cycles. Thomas-Fermi, Emden, and van der Pol equations.
Prerequisite: MAP 4305.

EGM 6322 Principles of Engineering Analysis II 3 Credits
Grading Scheme: Letter Grade
Partial differential equations of first and second order. Hyperbolic, parabolic, and elliptic equations including the wave, diffusion, and Laplace equations. Integral and similarity transforms. Boundary value problems of the Dirichlet and Neumann type. Green's functions, conformal mapping techniques, and spherical harmonics. Poisson, Helmholtz, and Schroedinger equations.
Prerequisite: MAP 4341.

EGM 6341 Numerical Methods of Engineering Analysis I 3 Credits
Grading Scheme: Letter Grade
Finite-difference calculus; interpolation and extrapolation; roots of equations; solution of algebraic equations; eigenvalue problems; least-squares method; quadrature formulas; numerical solution of ordinary differential equations; methods of weighted residuals. Use of digital computer.
Prerequisite: EGM 4313 or equivalent.

EGM 6342 Fundamentals of Computational Fluid Dynamics 3 Credits
Grading Scheme: Letter Grade
Fundamentals of computational fluid dynamics. Spatial discretisations, semi-discritisations, time-integration methods, full discretisations.
Prerequisite: EGM 6341 and EGM 6813 or consent of instructor.

EGM 6352 Advanced Finite Element Methods 3 Credits
Grading Scheme: Letter Grade
The discontinuous Galerkin method applied to transient problems. Optimization theory applied to formulating mixed FEM; treatment of constraints (e.g., incompressibility). General shape functions. Electromagnetics, heat, fluids, and solids. Other advanced topics.
Prerequisite: EML 5526.

EGM 6365 Structural Optimization 3 Credits
Grading Scheme: Letter Grade
Structural optimization via calculus of variations. Applying techniques of numerical optimization to design trusses, frames, and composite laminates. Calculating the sensitivity of structural response. Approximation and fast reanalysis techniques. Optimality criteria methods.
Prerequisite: EML 4500, EGM 4350,EML 5526, or EGM 6451.

EGM 6570 Principles of Fracture Mechanics 3 Credits
Grading Scheme: Letter Grade
Introduction to the mechanics of fracture of brittle and ductile materials. Linear elastic fracture mechanics; elastic-plastic fracture; fracture testing; numerical methods; composite materials; creep and fatigue fracture.
Prerequisite: EGM 6611.

EGM 6611 Continuum Mechanics 3 Credits
Grading Scheme: Letter Grade
Tensors of stress and deformation. Balance and conservation laws, thermodynamic considerations. Examples of linear constitutive relations. Field equations and boundary conditions of fluid flow.
Prerequisite: EGM 3520.

EGM 6671 Inelastic Materials 3 Credits
Grading Scheme: Letter Grade
Virtual work, stability, extremum principles. Applications on the microscale, miniscale, and macroscale. Thermodynamics, internal variables, damage parameters, and time and temperature effects. Fracture mechanics. Finite elastoplasticity.
Prerequisite: EGM 6611.

EGM 6812 Fluid Mechanics I 3 Credits
Grading Scheme: Letter Grade
Flow kinematics. Fundamental laws and equations in integral and differential forms. Potential flows. Introduction to laminar flows in simple geometries, laminar and turbulent boundary layer flows. External flows. One-dimensional compressible flows.
Prerequisite: EGN 3353C.

EGM 6813 Fluid Mechanics II 3 Credits
Grading Scheme: Letter Grade
Mathematical and physical structures of the Navier-Stokes equation. Exact solutions of the Navier-Stokes equation for viscous flows. Low Reynolds number flows. Incompressible and compressible laminar boundary layer flows. Free shear flows. Energy equation and heat transfer. Unsteady flows. Instability. Turbulence.
Prerequisite: EGM 6812.

EGM 6855 Bio-Fluid Mechanics and Bio-Heat Transfer 3 Credits
Grading Scheme: Letter Grade
Biothermal fluid sciences. Emphasizes physiological processes occurring in human blood circulation and underlying physical mechanisms, from an engineering perspective.
Prerequisite: undergraduate fluid mechanics.

EGM 6905 Individual Study 1-6 Credits, Max 12 Credits
Grading Scheme: Letter Grade
Individual Study

EGM 6934 Special Topics in Engineering Mechanics 1-6 Credits, Max 15 Credits
Grading Scheme: Letter Grade
Special Topics in Engineering Mechanics

EGM 6936 Graduate Seminar 1 Credit, Max 6 Credits
Grading Scheme: Letter Grade
Discussions and presentations in the fields of graduate study and research.

EGM 7819 Computational Fluid Dynamics 3 Credits
Grading Scheme: Letter Grade
Finite difference methods for PDE. Navier-Stokes equations for incompressible and compressible fluids. Boundary fitted coordinate transformation, adaptive grid techniques. Numerical methods and computer codes for fluid flow problems.
Prerequisite: EGM 6342 and EGM 6813 or equivalent.

EGM 7845 Turbulent Fluid Flow 3 Credits
Grading Scheme: Letter Grade
Definition of turbulence, basic equations of motion. Instability and transition. Statistical methods, correlation and spectral functions. Experimental methods, flow visualization. Isotropic homogeneous turbulence. Shear turbulence, similitude, the turbulent boundary layer, rough turbulent flow. Jets and wakes. Heat convection, thermally driven turbulence.
Prerequisite: EGM 6813 or equivalent.

EGM 7979 Advanced Research 1-12 Credits
Grading Scheme: S/U
Research for doctoral students before admission to candidacy. Designed for students with a master's degree in the field of study or for students who have been accepted for a doctoral program. Not appropriate for students who have been admitted to candidacy.

EGM 7980 Research for Doctoral Dissertation 1-15 Credits
Grading Scheme: S/U
Research for Doctoral Dissertation

EGN 5949 Practicum/Internship/Cooperative Work Experience 1-6 Credits, Max 6 Credits
Grading Scheme: S/U
Practical cooperative engineering work under approved industrial and faculty supervision.
Prerequisite: graduate student.

EGN 6640 Entrepreneurship for Engineers 3 Credits
Grading Scheme: Letter Grade
Introduction to entrepreneurship, idea generating and feasibility analysis, and business planning. Lectures, case studies, student-led discussions, team business plans, and investor presentations.

EGN 6913 Engineering Graduate Research 0-3 Credits, Max 12 Credits
Grading Scheme: S/U
Course will provide the student with supervised research in a laboratory setting.

EGN 6950 Engineering Capstone 3 Credits
Grading Scheme: Letter Grade
The Engineering Capstone is a culminating project experience for engineers. Students work on an individual project or in multidisciplinary teams of engineering students to design and build authentic products and processes—on time and within budget. While working with industry experts, students gain practical experience in teamwork and communication, problem solving and engineering design, and develop leadership, management, and people skills.
Prerequisite: Students in their final semester of their engineering MS degree.

EML 5045 Computational Methods for Design and Manufacturing 3 Credits
Grading Scheme: Letter Grade
Geometric and solid modeling, feature-based design, and parametric models. Applications to product design, rapid prototyping, and manufacturing.
Prerequisite: EML 3023 or consent of instructor.

EML 5104 Classical and Statistical Thermodynamics 3 Credits
Grading Scheme: Letter Grade
First and second laws of thermodynamics. Free energy and chemical equilibrium. Micro- and macroscopic states. Fermi-Dirac and Bose-Einstein statistics. Partition functions.

EML 5131 Combustion 3 Credits
Grading Scheme: Letter Grade
Chemical thermodynamics, chemical kinetics, flame propagation, detonation and explosion, combustion of droplets and spray.
Prerequisite: EML 3100 or equivalent.

EML 5215 Analytical Dynamics I 3 Credits
Grading Scheme: Letter Grade
Analytical methods of statics and dynamics. Principle of virtual work, holonomic and nonholonmic constraints. Lagrange equations for constrained and unconstrained systems, conservation laws, stability analysis by perturbation about steady state, Jacobi first integral, generalized impulse and momentum.
Prerequisite: dynamics.

EML 5223 Structural Dynamics 3 Credits
Grading Scheme: Letter Grade
Vibration analysis and synthesis of continuous and multidegree-of-freedom lumped-parameter systems. Computational and experimental techniques in modal analysis.
Prerequisite: EML 4220.

EML 5224 Acoustics 3 Credits
Grading Scheme: Letter Grade
Theory of sound. Plane waves and three-dimensional acoustic fields. Sound transmission and reflection. Dissipation, radiation, and scattering.
Prerequisite: ENG 3353C, EGM 4313, or consent of instructor.

EML 5233 Failure of Materials in Mechanical Design 3 Credits
Grading Scheme: Letter Grade
Evaluation of fatigue life of machine elements and aerospace structures. Steady and alternating multi-axial stress. High cycle fatigue and low cycle fatigue.
Prerequisite: 6EG, 7EG, 8EG, 9EG, or EML3005

EML 5311 Control System Theory 3 Credits
Grading Scheme: Letter Grade
Analyzing dynamic mechanical engineering control systems. Introduction to classical, digital, and state space techniques. Modeling, stability, transient response, and frequency response. Considers implementation.

EML 5318 Computer Control of Machines and Processes 3 Credits
Grading Scheme: Letter Grade
Basic concepts, including hardware and software. Modeling of machines, processes, and their controllers.
Prerequisite: CGS 2425 or consent of instructor.

EML 5465 Energy Management for Mechanical Engineers 3 Credits
Grading Scheme: Letter Grade
Energy use analysis in building envelopes, mechanical systems, and industrial processes. Energy conservation strategies and design techniques. Alternative energy applications.
Prerequisite: consent of instructor.

EML 5515 Gas Turbines and Jet Engines 3 Credits
Grading Scheme: Letter Grade
Theory and analysis of gas turbine engines and major components.
Prerequisite: EGN 3353C or EAS 4101 or equivalent.

EML 5516 Design of Thermal Systems 3 Credits
Grading Scheme: Letter Grade
Modeling of thermal equipment; system simulation; optimization, search methods, thermal system design and optimization using dynamic, geometric, and linear programming; simulation of large systems, vector and reduced gradient searches.
Prerequisite: (EGN 3353C and EML 4140) or equivalent.

EML 5526 Finite Element Analysis and Application 3 Credits
Grading Scheme: Letter Grade
Fundamentals, including discrete system analysis, dynamic analysis of structures, steady state and transient heat transfer analysis, and incompressible fluids analysis. Modeling, analysis, and design using FEA software.
Prerequisite: EGM 3520 or equivalent.

EML 5598 Orthopedic Biomechanics 3 Credits
Grading Scheme: Letter Grade
Mechanical properties of the human body's hard and soft tissues. Mechanical and biological considerations for repair and replacement of soft and hard tissues and joints. Fracture fixation, orthopedic implants for hip and knee, and orthotic and prosthetic devices.
Prerequisite: mechanics of materials.

EML 5605 Advanced Refrigeration 3 Credits
Grading Scheme: Letter Grade
Analysis and design considerations for vapor compression, absorption, steam-jet, thermoelectric, and air refrigeration systems.
Prerequisite: EML 4601.

EML 5714 Introduction to Compressible Flow 3 Credits
Grading Scheme: Letter Grade
One-dimensional and quasi-one-dimensional compressible fluid flows. Mach waves, normal shocks, oblique shocks, Prandtl-Meyer expansions, isentropic flow with area change, Fanno flow, Rayleigh flow.

EML 6048 Machine Learning and System Control 3 Credits
Grading Scheme: Letter Grade
Focuses on an area of machine learning for solving decision-making problems when there is uncertainty in sensing and control. Relies on recent advances in artificial intelligence and machine learning. Studies new data-driven methods for the control design of autonomous systems in unknown environments using reinforcement learning . Theory, algorithms, and Python/Matlab implementations of reinforcement learning and their applications to solve control problems for unmanned vehicles and robots.
Prerequisite: Undergraduate linear control or undergraduate statistics or undergraduate Python, Matlab, or similar programming course.

EML 6154 Conduction Heat Transfer 3 Credits
Grading Scheme: Letter Grade
Heat conduction in homogeneous, heterogeneous, isotropic, anisotropic, stationary, and moving bodies; in Cartesian, cylindrical and spherical systems. Examines exact and approximate solutions.
Prerequisite: (EML 4140 and MAP 2302) or equivalent.

EML 6155 Convective Heat Transfer I 3 Credits
Grading Scheme: Letter Grade
Applying equations of motion and energy to forced and free convection with laminar and turbulent flow. Solution techniques to include simplification to ordinary differential equations, boundary layer approximations, similarity transformations, and integral approximations. Phenomenological treatment of turbulent transport.
Prerequisite: (EGN 3353C and EML 4140) or equivalent.

EML 6156 Multiphase Convection Heat Transfer 3 Credits
Grading Scheme: Letter Grade
Detailed coverage of advanced convection heat transfer topics: boiling and condensation, high-velocity convection, transpiration cooling, convection around bodies, free jet flow, oscillating fluids, and microelectronic cooling.
Prerequisite: EML 6155.

EML 6157 Radiation Heat Transfer 3 Credits
Grading Scheme: Letter Grade
Theory and analysis of radiation exchange in transparent and absorbing, and emitting and scattering media.
Prerequisite: (EML 4140 and MAP 2302) or equivalent.

EML 6267 Advanced Manufacturing Processes and Analysis 3 Credits
Grading Scheme: Letter Grade
Integrated treatment of the analysis and applications of advanced manufacturing processes.

EML 6281 Geometry of Mechanisms and Robots I 3 Credits
Grading Scheme: Letter Grade
Developing applications to basic theory of the mathematics required to design spatial mechanisms and robot arms. Examples include mathematical description of the elements of mechanisms and robot arms (namely linkages and joints); their mobility and their analysis.

EML 6282 Geometry of Mechanisms and Robots II 3 Credits
Grading Scheme: Letter Grade
Applying the theory of screws to determine stationary and uncertainty configurations of mechanisms and robot arms. Dexterity and workspace of robot arms.

EML 6323 Nontraditional Manufacturing 3 Credits
Grading Scheme: Letter Grade
Focusing on nontraditional additive and subtractive manufacturing processes using electrical, chemical, ultrasonic, magnetic, and photonic energy - including processes and equipment.
Prerequisite: Graduate standing

EML 6324 Fundamentals of Production Engineering 3 Credits
Grading Scheme: Letter Grade
Fundamentals of metal cutting, metal forming, and welding. Accuracy and rigidity of machine tools. Automation, numerical control, adaptive control.

EML 6350 Introduction to Nonlinear Control 3 Credits
Grading Scheme: Letter Grade
Introduction to nonlinear analysis and control systems theory. Lyapunov-based analysis and design techniques.

EML 6351 Nonlinear Control II: Adaptive Control 3 Credits
Grading Scheme: Letter Grade
Control methods for uncertain nonlinear systems. Lyapunov-based robust, adaptive, learning, and estimation-based methods.
Prerequisite: EML 6350

EML 6352 Optimal Estimation and Kalman Filtering 3 Credits
Grading Scheme: Letter Grade
Methods of estimating parameters and random variables from noisy measurements with applications. State estimation of linear and non-linear dynamic systems with Kalman filtering and extended Kalman filtering, with mechanical and aerospace engineering applications such as target tracking.
Prerequisite: EML 5311 or EEL 5182 or Equivalent

EML 6364 Optimal Control 3 Credits
Grading Scheme: Letter Grade
Focuses on how to search for a mathematical function that allows for the optimal control of a system. Uses the Calculus of Variations applied to optimal control, linear-quadratic problem, Pontryagin's minimum principle, bang-bang optimal control, singular optimal control, introduction to parameter optimization, and numerical methods for optimal control.
Prerequisite: Undergraduate Controls course or Undergraduate Dynamics course or Undergraduate Numerical Methods course.

EML 6386 Computational Nanomechanics and Nanomaterials 3 Credits
Grading Scheme: Letter Grade
Modeling techniques in nanomechanics and nanomaterials. Modeling and simulation methods from atomistic to mesoscale domains with particular focus on "classical" atomistic modeling techniques: molecular mechanics, molecular dynamics, and Monte Carlo simulations. Applications include structural and thermomechanical properties of materials.
Prerequisite: Undergraduate level solid mechanics, material science, and physics. Matlab or Python programming and plotting.

EML 6417 Solar Energy Utilization 3 Credits, Max 6 Credits
Grading Scheme: Letter Grade
Fundamentals of solar radiation, basic heat transfer and thermodynamic topics with solar engineering applications, solar concentrating devices and flat plate solar absorbers, thermal storage, concentrating power generation systems, photovoltaic systems and state of the art and emerging solar technologies including thermochemical and electrochemical conversion and storage methods.
Prerequisite: EML 3100 or equivalent.

EML 6451 Energy Conversion 3 Credits
Grading Scheme: Letter Grade
Converting available forms of energy into mechanical and electrical forms; energy conversion schemes, including conventional cycles in unusual environments. MHD, photovoltaics, thermionic and thermoelectric conversion and fuel cells.

EML 6466 Industrial Energy Management 3 Credits
Grading Scheme: Letter Grade
Fundamental topics of energy management such as: energy-policy development, equipment energy usage (electric and thermal), process and equipment efficiencies, industrial processes analysis and optimization. Critical evaluation of new technology for use from technical and economical perspectives.
Prerequisite: Undergraduate thermodynamics and heat transfer courses (or equivalents).

EML 6573 Nonlinear Programming 3 Credits
Grading Scheme: Letter Grade
Focuses on the identification and formulation of convex optimization problems, where such problems are those nonlinear problems that have optimal solutions. Studies the principles for the selection of algorithms and their programmatic implementation to solve them Derives convergence rates and compares these rates across major classes of problems. Explores the application to problems in approximate optimal control, such as model predictive control and reinforcement learning.
Prerequisite: Undergraduate linear algebra course (e.g. EGM 3344 or MAS 3114 or MAS 4105 or MAS 4124) and Undergraduate programming course (e.g. COP 2171 or COP 2173 or COP 2174).

EML 6577 Verification, Validation, and Uncertainty Quantification 3 Credits
Grading Scheme: Letter Grade
In depth study of uncertainty, how to build system models based on uncertain data, how to determine the accuracy of the model, and how to verify, validate results. Covers the practical aspects of considering uncertainty and Bayesian statistics in the design process and the verification and validation of the resulting design.
Prerequisite: Graduate student standing and an Undergraduate course in programming.

EML 6606 Advanced Air Conditioning 3 Credits
Grading Scheme: Letter Grade
Air-conditioning system selection and system design; air-handling techniques including noise control, cleaning, and temperature and humidity control; modern technological development and economic analysis.
Prerequisite: EML 4600.

EML 6905 Individual Projects in Mechanical Engineering 1-3 Credits, Max 9 Credits
Grading Scheme: Letter Grade
Individual Projects in Mechanical Engineering

EML 6934 Special Topics in Mechanical Engineering 1-4 Credits, Max 15 Credits
Grading Scheme: Letter Grade
Special Topics in Mechanical Engineering

EML 6940 Supervised Teaching 1-3 Credits, Max 5 Credits
Grading Scheme: S/U
Provides students with supervised teaching experience on developing effective instructional methods and materials in engineering education as well as effective mentoring skills in a professional setting.
Prerequisite: MCE_PHD.

EML 6971 Research for Master's Thesis 1-15 Credits
Grading Scheme: S/U
Research for Master's Thesis

EML 7979 Advanced Research 1-12 Credits
Grading Scheme: S/U
Research for doctoral students before admission to candidacy. Designed for students with a master's degree in the field of study or for students who have been accepted for a doctoral program. Not appropriate for students who have been admitted to candidacy.

EML 7980 Research for Doctoral Dissertation 1-15 Credits
Grading Scheme: S/U
Research for Doctoral Dissertation