MECHE GRAD COURSE OFFERINGS FALL 2024 (updated 3.25.24)			
COURSE	**SECTION**	**DESCRIPTION**	**NOTES**
ENG EK505: Introduction to Robotics and Autonomous Systems	A1 - Alyssa Pierson Monday, Wednesday 2:30-4:15	This course will provide the foundation for the study of robotics and autonomous systems. Topics to be covered include modeling techniques (kinematics and dynamics) for a variety of robotic systems, ranging from manipulator arms and car-like vehicles to soft robots, an introduction to control and motion planning for such systems, and concepts of sensing and perception. The course will also discuss the basics of machine learning techniques in robotics and the ethical implications of the field as robotics and automation continue their progression into commonplace tools.	
ENG ME 500: Modeling of Motion in Mechanical Systems	A2 - Andrew Sabelhaus Tuesday, Thursday 1:30-3:15	This course develops students' ability to derive and simulate equations of motion for mechanical systems, fo-cusing on mechanics and dynamics in 3D. Students will learn how to deploy and solve Lagrange's equations of motion for systems of particles and rigid bodies, focusing on problems that involve environmental con-tact and constraints. We will compare and contrast different parameterizations of rotations, coordinate system choices, and minimal versus maximal coordinates for different applications. Total system energy will analyzed in connection with basic principles of nonlinear systems stability. Optimization methods will be introduced as a framework for efficient simulations. Assignments include analytical derivations for examples ranging from robotics to aerospace vehicles, as well as simulation development in software. A final project will require students to model a mechanical system, simulate its motion, and optionally validate versus hardware.	
ENG ME 500: Manufactoring Processes for Design and Production	A3 - Stephen Chompszak Tuesday, Thursday 1:30-3:15	Good product design requires an engineer to simultaneously consider how the product will function (Function), how it is detailed and what components are utilized (Form), what it is made of (Material), and how it is made (Manufacturing). This course will train students, using both theory and hands-on experience, how manufacturing processes and materials affect design decisions and details, and vice versa. The students will learn how the combination of Function, Form, Material and Manufacturing all impact Cost, Quality, and Schedule. In addition to an advanced introduction to major manufacturing methods, the course will review a number of related topics critical to the design process including: material selection, tolerancing, metrology, Design for Manufacturing, Design for Assembly, part and production costing, assembly and automation, and designing an assembly production line. The learnings will be reinforced through multiple projects in EPIC and will culminate with a multi-week capstone project incorporating the above.	**NOTE:** This course has a required lab component either on Tuesday, 9:00am-10:45am OR Thursday, 9:00am-10:45am.
ENG ME 501: Dynamic System Theory	A1 - John Bailieul Tuesday, Thursday 9:00-10:45	Introduction to analytical concepts and examples of dynamic systems and control. Mathematical description and state space formation of dynamic systems; modeling, controllability, and observability. Eigenvector and transform analysis of linear systems including canonical forms. Performance specifications. State feedback: pole placement and the linear quadratic regulator. Introduction to MIMO design and system identification using computer tools and laboratory experiments. Meets with ENG EC 501 and ENG SE 501; students may not receive credit for both.	**Areas: C**

ENG ME 505: Thermodynamics and Statistical Mechanics	A1 - Uday Pal Monday, Wednesday 2:30-4:15	The laws of thermodynamics; general formulation and applications to mechanical, electromagnetic and electromechanical systems; thermodynamics of solutions, phase diagrams; thermodynamics of interfaces, adsorption; defect equilibrium in crystals; statistical thermodynamics, including ensembles, gases, crystal lattices, and phase transitions. Same as ENGMS505; students may not receive credit for both.	
ENG ME 510: Production Systems Analysis	A1/DL - James Perkins Monday, Wednesday 6:30-8:15	Operations research and dynamic systems methods applied in modeling, analysis, and control of production systems. Inventory analysis and control for single and multi-item systems based on deterministic and stochastic demand models. Demand forecasting. Supply chain management. Machine, flow shop and job shop scheduling, project scheduling with PERT and CPM. Production control methods: MRP, MRP-II, Just-in-Time, and Kanban.	
ENG ME520: Acoustics I	A1 - Greg McDaniel Tuesday, Thursday 1:30-3:15	Introduction to wave propagation and sound. Derivation of the linear wave equation with emphasis on its origins in the conservation equations of fluid media and fluid equations of state. Plane wave and spherical wave propagation. Initial value and boundary value problems, including normal modes and waveguides. General concepts such as acoustic impedance and intensity. Lumped elements. The wave equation in horns and stratified media. Other topics may include biomedical ultrasound, acoustic levitation, etc... as time permits.	
ENG ME 521: Continuum Mechanics	A1 - Dimitrije Stamenovic Monday, Wednesday 12:20-2:05	The main goal of this course is to present a unified, mathematically rigorous approach to two classical branches of mechanics: the mechanics of fluids and the mechanics of solids. Topics will include kinematics, stress analysis, balance laws (mass, momentum, and energy), the entropy inequality, and constitutive equations in the framework of Cartesian vectors and tensors. Emphasis will be placed on mechanical principles that apply to all materials by using the unifying mathematical framework of Cartesian vectors and tensors. Illustrative examples from biology and physiology will be used to describe basic concepts in continuum mechanics. The course will end at the point from which specialized courses devoted to problems in fluid mechanics (e.g. biotransport) and solid mechanics (e.g. cellular biomechanics) could logically proceed; Same as ENG BE 521. Students may not receive credit for both.	
ENG ME 526: Simulation of Physical Processes	A1 - James Bird Tuesday, Thursday 1:30-3:15	Modern simulation methods are covered for describing and analyzing the behavior of realistic nonlinear systems that occur in the engineering and science disciplines. By developing and applying such methods and tools, much deeper understanding, insight, and control of novel technologies can be gained, thereby often greatly aiding technology development, and sometimes providing the leverage to turn a novel technology into a practical reality. Physical and numerical changes of scales necessary for modeling macro-, meso-, and nanoscopic phenomena will be covered. Advanced numerical methods will be addressed for attacking nonlinear partial differential equations, as well as key aspects of the finite element method. Extensive use will be made of the modern computational tools Mathematica and COMSOL. Examples will be covered that include problems in micro and nanoelectronics, bioengineering, material science, photonics, and physics. Connections of these examples to sensing instrumentation and control will be made. Same as MS 526. Students may not receive credit for both.	

ENG ME 533: Energy Conversion	A1 - Emily Ryan Monday, Wednesday 12:20-2:05	Thermodynamic and mechanical aspects of modern conventional energy conversion systems, including steam electric power plants, gas turbine and internal combustion engines, and refrigeration systems. Combined cycle and cogeneration are also considered, as well as economic and environmental aspects of energy conversion. Includes design project.	
ENG ME 538: Introduction to Finite Element Methods and Analysis	A1 - Harold Park Monday, Wednesday 10:10-11:55	This class serves as an introduction to linear finite element method, and its application to static and dynamic problems with an emphasis on solid mechanics. The first half of the course will use the stiffness and energy approaches to developing the finite element equations as applied to bars, beams and trusses. Lab sessions will focus on learning how to utilize commercially-relevant finite element software to find numerical solutions to problems in solid mechanics. The second half of the course will focus on developing the finite element method as one that is applicable as a general numerical method for solving ordinary and partial differential equations that arise in all areas of science and engineering, including solid and fluid mechanics, thermal systems and electrostatics.	NOTE: Lab TBA.
ENG ME 542: Advanced Fluid Mechanics	A1 - Kamil Ekinci Tuesday, Thursday 9:00-10:45	Incompressible fluid flow. Review of control-volume approach to fluids engineering problems, with advanced applications. Differential analysis of fluid motion. Derivation of full Navier-Stokes, Euler, and Bernoulli equations. Unsteady Bernoulli equation. Velocity potential and its application to steady 2D flows. Vorticity and vortex motion.	
ENG ME 560: Precision Machine Design and Instrumentation	A1/DL - Andre Sharon Monday, Wednesday 11:00-12:45	This interdisciplinary course teaches the student how to design, instrument, and control high-precision, computer-controlled automation equipment, using concrete examples drawn from the photonics, biotech, and semi-conductor industries. Topics covered include design strategy, high-precision mechanical components, sensors and measurement, servo control, design for controllability, control software development, controller hardware, as well as automated error detection and recovery. Students will work in teams, both in-classroom and out-of-classroom, to integrate and apply the material covered in class to a term-long multi-part design project in PTC Pro-Engineer or other comparable CAD system, culminating in a group presentation at the end of the class.	
ENG ME 566: Advanced Engineering Mathematics	A1 - Eytan Barouch Monday, Wednesday 4:30-6:15	Introduces students of engineering to various mathematical techniques which are necessary in order to solve practical problems. Topics covered include a review of calculus methods, elements of probability and statistics, linear algebra, transform methods, difference and differential equations, numerical techniques, and mathematical techniques in optimization theory. Examples and case studies focus on applications to several engineering disciplines. The intended audience for this course is advanced seniors and entering MS engineering students who desire strengthening of their fundamental mathematical skills in preparation for advanced studies and research.	

ENG ME 568: Soft Robotic Technologies	A1 - Tommaso Ranzani Monday, Wednesday 10:10-11:55	This course will introduce students to the field of soft robotics and more generally to non-conventional actuation (e.g. shape memory alloys, soft fluidic actuators, electroactive polymers, etc.) and sensing technologies (soft and flexible technologies based on resistive, capacitive, and optics). They will learn the fluid physics principles that drive them and how they can be designed, manufactured, and integrated into functional soft robotic systems. The class will have a substantial experimental hands-on component during which students will learn challenges and opportunities in the design, manufacturing, modeling, and control of such systems. They will also learn how to apply these technologies to address current shortcomings of traditional rigid robotics.	**Areas: D**
ENG ME 570: Robot Motion Planning	A1 - Roberto Tron Tuesday, Thursday 3:30-5:15	Provides an overview of state-of-the-art techniques for robot motion planning. The emphasis is on the algorithms. It covers topology of configuration spaces, potential functions, roadmaps, cell decompositions, sampling-based algorithms, and model checking approaches to robot motion planning and control.	**Area(s): C, P**
ENG ME 691: Advanced Product Design and Engineering	A1 - Steve Chomyszak Monday, Wednesday 2:30-4:15	Fall Semester; part of a two-term sequence with ENG ME 692 Advanced Product Design and Engineering is focused on the tools and skills enabling smart, practical product engineering choices. A "proactive" mechanical engineer creates products and systems that are functional, manufacturable and economically successful, even as user expectations and technologies evolve. Students are expected to perform original research on design and engineering trends, apply advanced engineering methods to specific examples, justify their their conclusions in design reviews, and ultimately create a manufacturable design prototype. Grading based on a mix of team and individual assignments.	
ENG ME 712: Applied Mathematics in Mechanics	A1 - Douglas Holmes Tuesday, Thursday 9:00-10:45	The goal of this course is to give students an introduction to mathematical tools for solving difficult mathematics problems that arise in engineering science and mechanics. Students will learn the process of applied mathematics, which will enable them to take a hard problem, and gain insight into its important characteristics. Analytical theory, approximate techniques, and numerical methods will be used in a complementary manner to solve challenging engineering problems. Students will learn dimensional analysis and scaling, perturbation methods applied to polynomial and differential equations, variational calculus, integral equations, and concepts of stability and bifurcation. Students will apply these methods to mathematical problems in solid mechanics, thermodynamics, and dynamical systems.	

Non-ME Courses (RAS-related)			
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ENG EC 503: Introduction to Learning from Data	A1 - Francesco Orabona Tuesday, Thursday 1:30-3:15	This is an introductory course in statistical learning covering the basic theory, algorithms, and applications. This course will focus on the following major classes of supervised and unsupervised learning problems: classification, regression, density estimation, clustering, and dimensionality reduction. Generative and discriminative data models and associated learning algorithms of parametric and non-parametric varieties will be studied within both frequentist and Bayesian settings in a unified way. A variety of contemporary applications will be explored through homework assignments and a project.	**Area(s): ML** **NOTE: Students must regsiter for both the LECTURE and DISCUSSION Lab: Monday 6:30pm-815pm**
ENG EC 504: Advanced Data Structures	A1 - Brian Kulis Tuesday, Thursday 11:00-12:45	Review of basic data structures and Java syntax. Data abstraction and object-oriented design in the context of high-level languages and databases. Design implementation from the perspective of data structure efficiency and distributed control. Tailoring priority queues, balanced search trees, and graph algorithms to real-world problems, such as network routing, database management, and transaction processing.	
ENG EC 518: Robot Learning	A1 - Eshed Ohn-Bar Monday, Wednesday 4:30-6:15	Planning and control of a project involving the definition, development and implementation of a system in which software provides essential functionality. Cost factors and cost estimation models; cost/benefit trade-offs, risk analysis; project metrics for quality, schedule, budget, and progress. Role of the project manager and organization of the development team. Case studies used to illustrate successes and failures in the management of actual projects. Small- team projects involving the development of project plans for a system that requires software development and hardware-software integration.	**Area(s): ML , P**
ENG ESE/EC 523: Deep Learning	A1 - Kayhan Batmanghelich Monday, Wednesday 2:30-4:15	Mathematical and machine learning background for deep learning. Feed-forward networks., Backpropagation. Training strategies for deep networks. Convolutional networks. Recurrent neural networks. Deep reinforcement learning. Deep unsupervised learning. Exposure to Tensorflow and other modern programming tools. Other recent topics, time permitting. Same as CAS CS 523 and ENG SE 523. Students may not receive credit for both.	**Area(s): ML**
ENG EC 545: Cyber-Physical Systems	A1 - Wenchao Li Monday, Wednesday 10:10-11:55	This course introduces students to the principles underlying the design and analysis of cyber-physical systems - computational systems that interact with the physical world. We will study a wide range of applications of such systems ranging from robotics, through medical devices, to smart manufacturing plants. A strong emphasis will be put on building high-assurance systems with real-time and concurrent behaviors. The student will gain both in-depth knowledge and hands-on experience on the specification, modeling, design, and analysis of representative cyber-physical systems. Meets with ENG SE 545. Students may not receive credits for both.	**Area(s): D**

ENG EC 602: Design By Software	A1 - Jefferey Carruthers Tuesday, Thursday 11:00-12:45	Software plays a central role in all aspects of electrical and computer engineering. This course will provide the foundation for effectively using software as a key part of a career as a professional electrical or computer engineer. Fundamentals of software development systems: system languages, high-level object-oriented languages, and computational languages. Data structures and algorithms in problem analysis and design. Strategies for designing software and designing with software. Software design and development: methodologies, principles and practice. Formalizing software: management, requirements, specifications, testing. Survey of software applications in ECE, including real-time systems, the web, networked systems, audio, graphics, and video systems, research and engineering analysis, consumer electronics and computing, instrumentation and measurement, design, modeling, prototyping, simulation, optimization and information analysis. Students can choose projects and assignments with application to/inspired by/drawn from a broad array of ECE fields including the traditional areas of electro-physics/photonics, computer engineering, and information and data science.	
CAS CS 541: Applied Machine Learning	A1 -Bryan Plummer Tuesday, Thursday 5:00-6:15	Covers practical skills in machine learning including techniques for clustering, classification, regression, feature selection, and model compression. Emphasizes hands-on application of methods via programming on real- world datasets.	**Area(s): ML** **NOTE: Students must regsiter for both the LECTURE and a Wednesday DISSERTATION section.**
CAS CS 542: Principles of Machine Learning	A1 - Kate Saenko Monday, Wednesday 11:00-12:15	Introduction to modern machine learning concepts, techniques, and algorithms. Topics include regression, kernels, support vector machines, feature selection, boosting, clustering, hidden Markov models, and Bayesian networks. Programming assignments emphasize taking theory into practice, through applications on real-world data sets.	**Area(s): ML** **NOTE: Students must regsiter for both the LECTURE and a Thursday LAB section.**