ENGR - ENGINEERING

ENGR 1105 Concepts of Engineering (2-3-3)
The Concepts of Engineering course will cover a wide range of theory and concepts including: elementary theory in mathematics and physics (essential to Engineering Science); the interaction of logic and mathematics fundamental to engineering and computing; the design skills and processes fundamental to multiple fields of engineering; communications skills and teamwork.

ENGR 1255 Introduction to Engineering and Ethics (2-3-3)
The engineering profession; solving engineering analysis problems; applying computer tools for engineering problem solving; investigating professional ethics, responsibilities and quality control in engineering.

ENGR 1375 Computing for Engineers (2-3-3)
Foundations of computing, using a high-level structured programming language, with emphasis to design, analysis of algorithms and an introduction to design and construction of programs for solving engineering problems.
Prerequisite(s): MATH 1131

ENGR 1701 Introduction to Robotics (1-0-1)
Introduction to topics relevant to the history and future of robotics. Ethics in engineering will be covered. Introduction to applications of robotics in research, military, and industrial settings.

ENGR 2115 Statics (3-0-3)
Elements of statics in two and three dimensions, centroids, analysis of structures and machines, friction
Prerequisite(s): (MATH 1132 with a minimum grade of C and PHYS 2211 with a minimum grade of C and PHYS 2311 with a minimum grade of C)

ENGR 2117 Circuits and Electronics (3-0-3)
An introduction to electric circuits and electronic devices; both analog and digital systems are considered.
Prerequisite(s): (PHYS 2212 and MATH 1132)

ENGR 2125 Dynamics of Rigid Bodies (3-0-3)
Kinematics and dynamics of particles and rigid bodies in one, two and three dimensions. Work-energy and impulse-momentum concepts.
Prerequisite(s): ENGR 2115 with a minimum grade of C

ENGR 2155 Strength of Materials (3-0-3)
Stress and strain, axially loaded members, torsion of circular sections, bending of beams, transformation of stress and strain, and column buckling.

ENGR 2165 Thermodynamics (3-0-3)
Fundamentals of thermodynamics, pure substance, conservation of energy, the second law of thermodynamics, multi phase mixtures.
Prerequisite(s): MATH 1132

ENGR 2201 Robotics Engineering I (3-2-4)
This course will provide students with a detailed examination of topics in systems engineering and design by focusing on the field of robotics. Students will learn how to integrate previously developed components (such as power supplies, robotic arms, motion bases and control platforms) into an overall engineering solution that is practical, affordable, and meets defined specifications. In this course, students will study the history of robots and robotic systems, as well as gain hands-on experience by working with robotic systems in the laboratory and in the field. (Course Fee Required)

ENGR 2206 Digital Logic (3-3-4)
Digital logic is the foundation of digital computer systems. In the course of this class, students will learn the basics of digital logic, from gate-level design through systems that make up a computer.

ENGR 2217 Robotics Engineering Design (3-2-4)
Students will explore how robotic systems work beneath the skin. Building on principles from ENGR 2206, students will investigate the proper steps required to design and build a robot from start to finish. This course will further develop topics in systems engineering and design by focusing on the field of robotics. Students will gain hands-on experience by working with robotic systems in the laboratory and in the field. (Course fee required)
Prerequisite(s): ENGR 2206 with a minimum grade of C or CPSC 2105 with a minimum grade of C

ENGR 2221 Computing for Engineers 1 (2-3-3)
Foundations of computing, using a high-level structured programming language, with emphasis to design, analysis of algorithms and an introduction to design and construction of programs for solving engineering problems.
Prerequisite(s): MATH 1131 with a minimum grade of C

ENGR 2222 Computing for Engineers 2 (2-3-3)
Further use of high-level programming languages, including complex algorithms, memory usage, and applications to robotics-related engineering problems.
Prerequisite(s): ENGR 2221 with a minimum grade of C

ENGR 2235 Basic Electric Circuits (1-4-3)
This project-based course is intended for students wishing to pursue a Robotics Certificate at the university level. It introduces the basic concepts and theory of electric circuits with an emphasis on electrical elements such as resistors, inductors, and capacitors (RLC) and their applications in alternating current (AC) or direct current (DC) circuits. Students also learn how to build, test and analyze simple RLC circuits in the laboratory, and use simulation software and test equipment such as power supply, multimeter, signal/function generator, oscilloscope, and spectrum analyzer. Related mathematics and physics concepts are developed alongside these concepts of electrical engineering.

ENGR 2255 Engineering Graphics and Computer Aided Design (2-3-3)
Theory and application of the design process, elements of projection theory, computer-aided design - 3-D modeling.

ENGR 2256 Engineering Graphics and Modeling (1-3-2)
This course covers engineering graphics, visualization and 3-D solid modeling. Students model all individual parts, create detail drawings for manufacturing/construction with bill of materials (BOM), and create an assembly drawing of the design. Working in a team environment is an essential part of this course.
Prerequisite(s): ENGR 2255 with a minimum grade of C

ENGR 2555 Selected Topics in Engineering (3-(0-2)-(3-4))
Course will encourage students to pursue additional experiences with, or a deeper understanding of, specific topics in engineering and system design. Students may be required to participate in laboratory or field activities, including at remote locations. Course may be taken two times for credit.
Prerequisite(s): (PHYS 1111 with a minimum grade of C and MATH 1113 with a minimum grade of C)
Repeatability: Repeatable for credit up to 1 times or 8 hours.

ENGR 3235 Circuit Analysis (2-3-3)
Number/hours change, prerequisite change DC and AC circuits. Two-ports and multi terminal networks. Time domain analysis. Laplace transform.
Prerequisite(s): MATH 3107 with a minimum grade of C and PHYS 2212 with a minimum grade of C and PHYS 2312 with a minimum grade of C

ENGR 3236 Introduction to Signal Processing (2-3-3)
Introduction to signal processing for discrete-time and continuous-time signals; topics include filtering, frequency response, Fourier transform, and Z-transform. Laboratory emphasizes computer-based signal processing.
Prerequisite(s): MATH 1131 with a minimum grade of C

ENGR 3245 Robotics Engineering Design Lab (1-3-2)
Students will explore how robotic systems work beneath the skin. Building on basic principles, students will investigate the proper steps required to design and build a robot from start to finish. This course will further develop topics in systems engineering and design by focusing on the field of robotics. Students will gain hands-on experience by working with robotic systems in the laboratory and in the field. Focus on team engineering design work, budgeting, robust mechanical and software design, and environmental interaction.
Prerequisite(s): ENGR 2206 with a minimum grade of C and ENGR 2221 with a minimum grade of C

ENGR 3250 Principles of Sensors and Actuators (1-4-3)
This project-based course offers students pursuing a Robotics Certificate the opportunity to examine a variety of sensors and actuators, used in robotic systems. Students will inspect robotic sensors such as accelerometers, auto-encoders, proximity sensors, dissect their working principles and investigate their operation experimentally. Furthermore, students will combine these robotic sensors with various actuators, such as DC motors and servomotors to construct their own robotic systems, using a dedicated Arduino microcontroller.

ENGR 3255 Sensors and Actuators (2-3-3)
Course covers sensors such as resistive temperature sensors, capacitive touch sensors, and inductive motion sensors and actuators. Numerous applications are presented to motivate coverage of the fundamental operating principles of circuit elements such as resistors, capacitors, and inductors; modded signals produced by these sensors; and analysis of circuits and systems used to amplify and process these signals. Concepts reinforced with the use of laboratory exercises and computer simulation.
Prerequisite(s): ENGR 3236 with a minimum grade of C and ENGR 3235 with a minimum grade of C

ENGR 3275 Feedback Control Systems (2-3-3)
Prerequisites: ENGR 3235 with a grade of C or better. Basic techniques for analysis and design of controllers, applicable in any industry. Both time and frequency domain methods are covered. Root locus, Nyquist and Bode plot-based techniques are outlined.
Prerequisite(s): ENGR 3235 with a minimum grade of C

ENGR 4299 Undergraduate Research (1-4-3)
Student will conduct research in robotics engineering under the guidance of a faculty mentor.
Restriction(s):
Enrollment limited to students in the Department Prerequisite college.

ENGR 4391 Robotics Senior Design 1 (0-4-2)
Students will conduct research as a capstone to their 4-year robotics engineering degree. Students will design, integrate, test, and demonstrate the performance of a robotic system. In addition, students will learn and apply project management techniques to manage the technical scope, schedule, budget, and risks of their project. There are monthly reviews of status and progress. For each review, the student will present progress and submit an updated version of the system design and development document.
Prerequisite(s): ENGR 3275 with a minimum grade of C
Restriction(s):
Enrollment limited to Senior students.

ENGR 4392 Robotics Senior Design 2 (0-4-2)
Continuation of undergraduate capstone research. Students will complete and demonstrate their robotic project. Monthly reviews continue. Students will write and present a conference-level paper of their project. Students will give a special demonstration of their project for the public and the broader robotics community.
Prerequisite(s): ENGR 4391
Restriction(s):
Enrollment limited to Senior students.

ENGR 4555 Selected Topics in Robotics ((2-3)-(0-3)-3)
Course will encourage students to pursue additional experiences with, or a deeper understanding of, specific topics in engineering and system design. Students may be required to participate in laboratory or field activities, including at remote locations. Course may be taken two times for credit.

ENGR 4698 Undergraduate Internship (0-(3-12)-(1-4))
Approved engineering work experience, either as a volunteer or through employment. An internship experience must be approved in advance. Successful completion requires written evaluation from a supervisor and an oral presentation to faculty and students.
Restriction(s):
Enrollment limited to Junior or Senior students.

ENGR 5151G Computer Vision 1 (3-0-3)
The course lays a framework for the extraction of useful information from images. Topics include representations of visual content (e.g., functions, points, graphs); visual invariance; mathematical and computational models of visual content; optimization methods for vision. Theoretical treatment and concrete examples, e.g., feature learning, segmentation image stitching, both covered.
Restriction(s):
Enrollment limited to students major in Robotics or Robotics Engineering.

ENGR 5151U Computer Vision 1 (3-0-3)
Prerequisites: ENGR 3236 and ENGR 3255, each with a grade of C or better. The course lays a framework for the extraction of useful information from images. Topics include representations of visual content (e.g., functions, points, graphs); visual invariance; mathematical and computational models of visual content; optimization methods for vision. Theoretical treatment and concrete examples, e.g., feature learning, segmentation image stitching, both covered.
Prerequisite(s): ENGR 3236 with a minimum grade of C and ENGR 3255 with a minimum grade of C

ENGR 5161G Elements of Machine Intelligence (3-0-3)
Introduction to the core concepts of AI, organized around building computational agents. Emphasizes the application of AI techniques. Topics include search, logic, knowledge representation, reasoning, planning, decision making under uncertainty, and machine learning.
Restriction(s):
Enrollment limited to students major in Robotics or Robotics Engineering.

ENGR 5161U Elements of Machine Intelligence (3-0-3)
Introduction to the core concepts of AI, organized around building computational agents. Emphasizes the application of AI techniques. Topics include search, logic, knowledge representation, reasoning, planning, decision making under uncertainty, and machine learning.
Prerequisite(s): ENGR 2221 with a minimum grade of C and ENGR 3236 with a minimum grade of C and MATH 3175 with a minimum grade of C

ENGR 5176G Kinematics and Dynamics (3-0-3)
This design-oriented course addresses the kinematics and dynamics of robotic systems. Conventional as well as innovative rigid body dynamic systems are studied. Problems of kinematics and dynamics are framed in a form suited for computer analysis. The course bridges analysis and design by emphasizing the simulation of industrial robot manipulators.
Restriction(s):
Enrollment limited to students major in Robotics or Robotics Engineering.

ENGR 5176U Kinematics and Dynamics (3-0-3)
This design-oriented course addresses the kinematics and dynamics of mechanisms with applications to linkage systems, reciprocating engines, and industrial machinery. Conventional as well as innovative rigid body dynamic systems are studied. Problems of kinematics and dynamics are framed in a form suited for computer analysis. The course bridges analysis and design by emphasizing the syntheses of mechanisms. To stimulate a creative approach, homework and project work draw upon actual engineering design problems drawn from manufacturing and other domains.
Prerequisite(s): ENGR 3275 with a minimum grade of C and ENGR 2125 with a minimum grade of C

ENGR 5236G Microelectronic Circuits (2-3-3)
Treatment of the fundamental behavior of semiconductor materials. Semiconductor diodes, bipolar transistors, and field effect transistors. Numerous circuit applications are considered, including: power supplies, transistor amplifiers, and FET switches. Topics include: PN junction, diode operation, transducers, electrification, voltage regulation, limiting and clamping circuits, transistor operation, biasing, small-signal and large-signal models, transistor amplifiers, and switching applications.
Restriction(s):
Enrollment limited to Degree - Graduate students.
Enrollment limited to students major in Robotics or Robotics Engineering.

ENGR 5236U Microelectronic Circuits (2-3-3)
Prerequisites: ENGR 3235 and ENGR 2206, each with a grade of C or better. Treatment of the fundamental behavior of semiconductor materials. Semiconductor diodes, bipolar transistors, and field effect transistors. Numerous circuit applications are considered, including: power supplies, transistor amplifiers, and FET switches. Topics include: PN junction, diode operation, transducers, electrification, voltage regulation, limiting and clamping circuits, transistor operation, biasing, small-signal and large-signal models, transistor amplifiers, and switching applications.
Prerequisite(s): ENGR 3235 with a minimum grade of C and ENGR 2206 with a minimum grade of C

ENGR 5238G Introduction to Embedded Systems (2-3-3)
Principles of designing application-specific computer systems that interact with the physical world. Covers memory-mapped I/O, interrupts, analog interfacing, microprocessors, reconfigurable hardware, sensors, and actuators. Complex hardware/software systems design and implementation. Substantial student-defined team design project. Students will solve real-world design problems using small, resource-constrained computing platforms. Laboratory emphasis is placed on interfacing embedded processors with common sensors and devices while developing the skills needed to use embedded processors in systems design.
Prerequisite(s): ENGR 5236G with a minimum grade of C
Restriction(s):
Enrollment limited to students major in Robotics or Robotics Engineering.

ENGR 5238U Introduction to Embedded Systems (2-3-3)
Principles of designing application-specific computer systems that interact with the physical world. Covers memory-mapped I/O, interrupts, analog interfacing, microprocessors, reconfigurable hardware, sensors, and actuators. Complex hardware/software systems design and implementation. Substantial student-defined team design project. Students will solve real-world design problems using small, resource-constrained computing platforms. Laboratory emphasis is placed on interfacing embedded processors with common sensors and devices while developing the skills needed to use embedded processors in systems design.
Prerequisite(s): ENGR 5236U with a minimum grade of C and ENGR 2125 with a minimum grade of C and ENGR 2206 with a minimum grade of C and ENGR 3255 with a minimum grade of C
Restriction(s):
Degree - Graduate students may **not** enroll.
Enrollment limited to students major in Robotics or Robotics Engineering.

ENGR 5899G Independent Study (0-0-(1-3))
An opportunity to study an engineering topic or carry out a research project in an area of interest. A proposal must be submitted to the program director by the midpoint of the semester prior to the one in which the study is to be undertaken. The proposal must be approved and a faculty mentor identified before registration. Assessment of this study will include a public presentation.
Repeatability: Repeatable for credit up to 2 times or 3 hours.

ENGR 5899U Independent Study (0-0-(1-3))
An opportunity to study an engineering topic or carry out a research project in an area of interest. A proposal must be submitted to the program director by the midpoint of the semester prior to the one in which the study is to be undertaken. The proposal must be approved and a faculty mentor identified before registration. Assessment of this study will include a public presentation.
Repeatability: Repeatable for credit up to 2 times or 3 hours.
Restriction(s):
Freshman, Sophomore or Junior students may **not** enroll.
Enrollment limited to students major in Robotics or Robotics Engineering.

ENGR 6000 Thesis Defense (0-0-0)
The course requires a successful oral defense of the master's thesis, the completion of edits and approval by the advisor or committee, and submission to the library. Degree candidates must be enrolled in this course during the semester of their thesis defense
Restriction(s):
Enrollment limited to students in the Department Prerequisite college.

ENGR 6137 Dynamic Optimization (3-0-3)
This course surveys the use of optimization (especially optimal control) to design behavior. We will explore ways to represent policies, including hand-designed parametric functions, basic functions, tables, and trajectory libraries. We will also explore algorithms to create policies including parameter optimization and trajectory optimization (first and second order gradient methods, sequential quadratic programming, random search methods, evolutionary algorithms, etc.).
Prerequisite(s): ENGR 6172 with a minimum grade of C

ENGR 6145 Human-Robot Interactions (3-0-3)
Basic subsystems of control, localization, mapping, perception, and planning are present. Discussion includes relevant methods from applied mathematics. Aspects of physics necessary in construction of systems and environmental behavior, and core algorithms which have proven to be valuable in a wide range of circumstances. Includes psychological effects of robot interactions on humans, the uncanny valley effect, and public opinion on interaction with robots.
Prerequisite(s): ENGR 5161G with a minimum grade of C and ENGR 5151G with a minimum grade of C

ENGR 6148 Military Applications in Robotics (3-0-3)
Covers applications of robotic systems for military use, including targeting and sensing, terrain traversal, decision-making, electronic countermeasures, and robust field design.
Prerequisite(s): ENGR 5161G with a minimum grade of C and ENGR 5176G with a minimum grade of C and ENGR 5151G with a minimum grade of C

ENGR 6152 Computer Vision 2 (3-0-3)
The course discusses advanced topics and current research in computer vision. Topics will be selected from various subareas such as physics based vision, geometry, motion and tracking, reconstruction, grouping and segmentation, recognition, activity and scene understanding, statistical methods and learning, systems and applications.
Prerequisite(s): ENGR 5151G with a minimum grade of C

ENGR 6162 Machine Intelligence and Synthesis (3-0-3)
An advanced exploration of artificial intelligence methods, including predicate calculus, language processing, mobile robot applications, and advanced learning methods.
Prerequisite(s): ENGR 5161G with a minimum grade of C

ENGR 6167 Multi-Robot Systems (3-0-3)
Covers applications in robot systems containing more than one physical machine. Includes swarm robot systems, master-slave systems, and adaptability to environmental changes.
Prerequisite(s): ENGR 5161G with a minimum grade of C

ENGR 6172 Multivariable Linear Controls (3-0-3)
Control design, concepts for linear multivariable systems, review of single variable systems and extensions to multivariable systems. Purpose of feedback, sensitivity, robustness, and design tradeoffs. Design formulations using both frequency domain and state space descriptions. Pole placement/observer design. Linear quadratic gaussian-based design methods. Design problems unique to multivariable systems.

ENGR 6173 Nonlinear Controls (3-0-3)
Geometric and algebraic approach to the analysis and design of nonlinear control systems. Nonlinear controllability and observability, feedback stabilization and linearization, asymptotic observers, tracking problems, trajectory generation, zero dynamics and inverse systems, singular perturbation, and vibrational controls.
Prerequisite(s): ENGR 6172 with a minimum grade of C

ENGR 6178 Biomechanics (3-0-3)
This course covers all aspects of anatomical design systems and programming. Applications include prosthetics, mechanical braces, realistic human-like movements, and medical applications.
Prerequisite(s): ENGR 5176G with a minimum grade of C

ENGR 6199 Mechanical and Electrical Engineering Fundamentals (3-0-3)
Kinematics and dynamics of particles and rigid bodies in one, two and three dimensions. Work-energy and impulse-momentum concepts. Electric circuits with an emphasis on electrical elements such as resistors, inductors, and capacitors and their applications in alternating current or direct current circuits. The basics of digital logic, from gate-level design through systems that make up a computer. Signal processing for discrete-time and continuous-time signals; topics include filtering, frequency response, Fourier transform, and Z-transform.
Restriction(s):
Enrollment is limited to Graduate Level level students.

ENGR 6239 Embedded Systems Design (2-3-3)
Basic interdisciplinary concepts needed to implement a microprocessor based on control systems, sensors and actuators, quadrature decoding. Pulse width modulation. DC motors. Force feedback algorithms for human/computer interaction. Real time operating systems. Networking. Use of Matlab to model hybrid dynamic systems.
Prerequisite(s): ENGR 5238G with a minimum grade of C

ENGR 6399 Graduate Research Project (0-6-3)
Graduate capstone research project. Approval of research topic by student's advisory committee. Students will write and present a conference-level paper of their project. Students will give a special demonstration of their project for the public and the broader robotics community. May be taken up to two times for credit.

ENGR 6555 Selected Topics in Robotics (3-0-3)
Course will encourage students to pursue additional experiences with, or a deeper understanding of, specific topics in engineering and system design. Students may be required to participate in laboratory or field activities, including at remote locations. Course may be taken two times for credit.

ENGR 6689 Supervised Graduate Internship (0-9-3)
Approved engineering work experience, either as a volunteer or through employment. An internship experience must be approved in advance. Successful completion requires written evaluation from a supervisor and an oral presentation to faculty and students. May be taken up to two times for credit.

ENGR 6999 Thesis Research (0-0-(1-9))
Supervised master's thesis research.
Repeatability: Repeatable for credit up to 3 times or 9 hours.
Restriction(s):
Enrollment limited to students in the Department Prerequisite college.