ELECTRICAL & COMPUTER ENGINEERING (ECE)

ECE 509 - Special Topics in Electrical and Computer Engineering (0.0-9.0 hours)
Topics of special interest which may vary each time course is offered. Topic stated in the current Schedule of Classes. Students may repeat the course under different topic names up to a maximum of 9 credits.
Prerequisite: Approval of instructor.

ECE 510 - Special Topics in Electrical and Computer Engineering (0.0-9.0 hours)
Topics of special interest which may vary each time course is offered. Topic stated in the current Schedule of Classes. Students may repeat the course under different topic names up to a maximum of 9 credits.
Prerequisite: Approval of instructor.

ECE 531 - Communication Theory I (3.0 hours)
Orthogonal signal representation; review of Fourier series and Fourier transform; basic probability theory; random processes; power spectral density; Shannon's channel capacity; sampling theorem; baseband signaling; bandpass signaling; complex envelop representation of signals and systems; analog modulations; binary and M-ary digital modulations; phase locked loops, demodulation circuits; matched filter; error performance in digital communications. Cross-listed as ECE 431.
Prerequisite: Graduate standing or a minimum grade of C in: ECE 206, ECE 302 or equivalents. Not open to students with credit in ECE 431.

ECE 541 - Feedback Control of Dynamic Systems (3.0 hours)
Analysis and design of linear automatic control systems for continuous-time dynamic systems using classical control theory. Fundamentals on feedback control theory. Root locus and Bode methods. Modeling and control of physical systems. Introduction to digital control. Computer-aided design and simulation. Cross listed as ECE 441.
Prerequisite: ECE206 or equivalent, or approval of instructor, or Graduate standing. Instructor's consent may be required. Not open to students with credits in ECE 441.

ECE 542 - Advanced Data-Driven Control and Applications (3.0 hours)
Frequency domain and time domain design of linear/nonlinear control systems. Analysis and design of linear/nonlinear control systems for sampled-data and discrete-time systems. Classical and modern control theory methods. Modeling and data driven system identification and control of sampled-data and discrete-time systems. Micro-controller-based control applications. Cross listed as ECE 442.
Prerequisite: ECE 541 or equivalent, or Graduate standing. Instructor's consent may be required. Not open to students with credits in ECE 442.

ECE 543 - Distributed Learning Control of Dynamic Systems (3.0 hours)
The analysis and control of distributed dynamic systems, distributed learning and control issues in dynamic systems, distributed control and estimation of multiple dynamic systems, use of fundamental tools in modeling and control of linear and nonlinear dynamic systems, applications of distributed learning and control for multiple dynamic systems through case studies in multiple robot coordination and distributed power grids. Cross-listed as ECE 443.
Prerequisite: Not open to students with credit in ECE 443.

ECE 544 - Autonomous Robotics (3.0 hours)
The project-based course deals with the fundamentals on autonomous robotic systems. It covers kinematics, sensors, and actuators of robots. Motion planning, control, and navigation techniques of autonomous mobile robots are introduced through a series of hands-on experiments. Cross-listed as ECE444.
Prerequisite: ECE103 or proficiency in programming in a structural computer programming language, ECE 214 or ECE 227, or graduate standing. Instructor's consent may be required. Not open to students with credit in ECE 444.

ECE 545 - Power Electronics Fundamentals (3.0 hours)
Fundamentals of power electronics. Covered topics: DC/DC converters, DC/AC converters (inverters), and AC/DC rectifiers, analysis, design, simulation and application of power electronic based systems. Cross-listed as ECE 445. Not open to students with credit in ECE 445.

ECE 546 - Power Laboratory (3.0 hours)
Experiments in transformers and rotating machines. Covered topics: electric machinery principles; brushed DC motor connections, operational characteristics, and applications; linear brushed DC motor model development, simulation, and verification; wound rotor and squirrel cage AC induction motor connections, operational characteristics, and applications; linear single-phase transformer model development and verification; power electronic H-bridge. Cross-listed as ECE 446. Not open to students with credit in ECE 446.
Prerequisite: ECE 303

ECE 550 - Electromagnetic Theory (3.0 hours)
Time-varying electric and magnetic fields; Maxwell's equations, electromagnetic potentials, electromagnetic boundary conditions, plane-wave propagation in unbounded conducting and non-conducting media, wave polarization, Poynting vector, reflection and transmission of waves at boundaries; radiation and antennas.Cross-listed as ECE 450.
Prerequisite: Graduate standing or a minimum grade of C in ECE 208. Not open to students with credits in ECE 450.

ECE 551 - Radio Frequency Circuits and Systems (3.0 hours)
Review of transmission lines, impedance matching and transformations, S-parameters, passive RF junctions, RF amplifier design, RF systems, and front-end design. Cross-listed as ECE 451.
Prerequisite: ECE 208 or equivalent, or graduate standing. Instructor's consent may be required. Not open to students with credit in ECE 451.

ECE 552 - Wireless Communication Systems (3.0 hours)
Introduction to wireless communication systems; modulation and detection; noise, attenuation; multipath and fading; sensitivity distortion, inter-modulation, and dynamic range; wireless link RF design; transmitter and receiver architectures; RF components and subsystems; selected wireless systems including multiple-access cellular systems. Cross-listed as ECE 452.
Prerequisite: Graduate standing or a minimum grade of C in: ECE 206, ECE 208, ECE 303 or equivalents. Not open to students with credit in ECE 452.

ECE 553 - Radio Frequency Communications Laboratory (3.0 hours)
Radio frequency measurements of wireless system components and subsystems, time and frequency domain measurements of analog and digital signals in communication systems, computer-aided design, fabrication, and testing of microwave integrated circuit. Cross-listed as ECE 453.
Prerequisite: ECE 551 with a minimum of B or equivalent. Not open to students with credit in ECE 453.

ECE 560 - Digital Signal Processing (3.0 hours)
Design of digital filters and multirate systems. Topics include: review of discrete-time signals and systems, generalized linear phase, all-pass filters, minimum phase systems, inverse systems, FIR filter design, IIR filter design, resampling in time and frequency domain, half-band filters, polyphase filters, quadrature mirror filters and wavelets. Cross-listed as ECE 460.
Prerequisite: Graduate standing or a minimum grade of C in ECE 301 or equivalent. Not open to students with credit in ECE 460.

ECE 562 - Digital Image Processing (3.0 hours)
Introduction to image processing. Topics covered: digital image fundamentals, image enhancements in spatial domain, image restoration, color image processing, wavelets and multiresolution, image compression, morphological image processing, image segmentation, pattern recognition. Cross-listed as ECE 462.
Prerequisite: ECE 103 or M E 273 or proficiency in computer programming in a structural language, or Graduate standing. Instructor's consent may be required. Not open to students with credit in ECE 462.

ECE 563 - Medical Imaging (3.0 hours)
Introduction to the common methods and devices employed for medical imaging, including conventional x-ray imaging, x-ray computed tomography (CT), nuclear medicine (single photon planar imaging), single photon emission computed tomography (SPECT), and positron emission tomography (PET), magnetic resonance imaging (MRI), and ultra-sound imaging. The physics and design of systems, typical clinical applications, medical image processing, and tomographic reconstruction. Cross-listed as ECE 463.
Prerequisite: Graduate standing or a minimum grade of C in ECE 206 or equivalent. Not open to students with credit in ECE 463.

ECE 565 - Engineering Applications of Machine Learning (3.0 hours)
This course covers the theory, design, and engineering applications of machine learning with the emphasis on computational intelligence. Embedded hardware platforms, high-performance libraries, and high-performance architectures are used for implementation. Variants such as Deep Neural Networks and Convolutional Neural Networks are examined. Cross-listed as ECE 465.
Prerequisite: Graduate standing or a minimum grade of C in ECE 302 or equivalent. Not open to students with credit in ECE 465.

ECE 568 - Mechatronics (3.0 hours)
Introduction to mechatronics: mechatronics overview, sensors and actuators modeling, interfacing sensors and actuators with digital systems. Cross-listed as ECE 468.
Prerequisite: ECE 214 or ECE 227, or Graduate standing. Instructor's consent may be required. Not open to students with credit in ECE 468.

ECE 570 - Embedded Data Structures and Object Oriented Programming (3.0 hours)
Introduction to data structures, object-oriented programming, memory management, problems of efficiency and complexity of algorithms applicable to embedded systems. Cross-listed as ECE 470.
Prerequisite: Graduate standing or a minimum grade of C in ECE 305 or proficiency in microcontroller programming in a structural computer language. Not open to students with credit in ECE 470. Instructor's consent may be required.

ECE 571 - Real-time Operating Systems (3.0 hours)
Advanced programming of small microprocessor-based systems using high-level programming languages applied to real situations: data acquisition, control, communication, small real-time operating systems. Software development for devices from a family of microcontrollers that is relevant to industrial applications. Cross-listed as ECE 471.
Prerequisite: Graduate standing or a minimum grade of C in ECE 305 or high proficiency in microcontroller programming in a structural computer language. Not open to students with credit in ECE 471. Instructor's consent may be required.

ECE 572 - Embedded Microcontroller Linux (3.0 hours)
Understanding of Linux and its adoption as an embedded OS platform, including process and thread management; communication, synchronization, and deadlocks; virtual memory and file systems; overview of methods and techniques to design and create embedded systems based on the Linux kernel. The essentials of the Linux operating system are discussed from the embedded system point of view, including selecting, configuring, cross-compiling, and installing a target-specific kernel, drivers, and subsystems; the GNU development tool chain; and tools used to build embedded Linux systems. Cross-listed as ECE 472.
Prerequisite: Graduate standing or a minimum grade of C in ECE 305 or proficiency in microcontroller programming in a structural computer language. Not open to students with credit in ECE 472. Instructor's consent may be required.

ECE 573 - Embedded TCP/IP (3.0 hours)
Fundamental concepts of computer networks and network programming; computer network topologies; TCP/IP stack; IP routing and routing algorithms; client-server paradigm; lower-layers protocols: IP, UDP, and TCP; basic application-layer protocols: HTTP, SMTP, POP3, TIME, TFTP, and DHCP; Berkeley Socket API; examples of socket API for small 8-bit or 16-bit embedded microcontroller system; principles of network security. Cross-listed as ECE 473.
Prerequisite: Graduate standing or a minimum grade of C in ECE305 or proficiency in microcontroller programming in a structural computer language. Not open to students with credit in ECE 473. Instructor's consent may be required.

ECE 574 - Mobile Robot Navigation and Mapping (3.0 hours)
Software aspects of simultaneous localization and mapping of mobile robots and cooperative multi-robot motion coordination. Cross-listed as ECE 474.
Prerequisite: ECE 570 or high proficiency in computer programming and data structures. Instructor's consent may be required. Not open to students with credit in ECE 474.

ECE 575 - Security for Industrial Automation (3.0 hours)
Introductory topics in industrial automation cyber-physical systems security, fundamental security primitives specific to cyber-physical systems, and their application to a broad range of current and future security challenges. Purdue Model for ICS Security. Industrial control systems as an example instance of cyber-physical systems. Not open to students with credit in ECE 475.
Prerequisite: Graduate standing or a minimum grade of C in ECE 305 or proficiency in microcontroller programming in a structural computer language. Not open to students with credit in ECE 475. Instructor's consent may be required.

ECE 581 - Digital Systems: Design and Synthesis (3.0 hours)
A structured guide to the modeling of the design of digital systems. Hardware description language (VHDL or Verilog) is used to simulate and synthesize designs. Reconfigurable devices such as FPGAs are used for design implementations. Assignments and projects of various engineering applications are included. Cross-listed as ECE 481.
Prerequisite: ECE 305 or equivalent, or graduate standing. Instructor's consent may be required. Not open to students with credit in ECE 481.

ECE 582 - Digital Systems: High Level Synthesis and Codesign (3.0 hours)
Introduce high level synthesis and codesign for System-on-a-Chip (SoC) using FPGA devices, which supports the concurrent design to effectively reduce multiple iteration and major redesigns in embedded systems. Topics covered: FPGA architecture and development tool flow, Introduction to SoC, customized IP design, system partition, hardware acceleration, and performance analysis, and FPGA design applications. Cross-listed as ECE 482.
Prerequisite: ECE 305 or equivalent, or Graduate standing. Instructor's consent may be required. Not open to students with credit in ECE 482.

ECE 583 - Digital Systems: Microprocessor Architecture and Design (3.0 hours)
Architectures of CISC & RISC microprocessors: CPU, Control Unit, ALU, MMU, pipelines, etc. Design trade-offs investigated. Cross-listed as ECE 483.
Prerequisite: A minimum grade of C in ECE 205 or equivalent, or graduate standing, or consent of the instructor. Not open to students with credit in ECE 483.

ECE 681 - Topics in Electrical Engineering (0.0-6.0 hours)
Topics of special interest which may vary each time course is offered. Topic stated in current Schedule of Classes. Repeatable to a maximum of 6 semester hours.

ECE 691 - Research I (0.0-6.0 hours)
Graduate research on a project selected by student and advisor. Repeatable to a maximum of 6 semester hours.

ECE 699 - Thesis (0.0-6.0 hours)
Advanced electrical and computer engineering research or design under the guidance of a faculty advisor. Required of students choosing thesis option. Repeatable to a maximum of 6 semester hours.
Prerequisite: Consent of department chair; unconditional status.