ECE - ELECTRICAL AND COMPUTER ENGINEERING

ECE 2050 Object-Oriented Programming for Electrical and Computer Engineering Cr. 3
Rigorous project-based, object-oriented programming course in C++ for ECE with an overview of computer engineering and systems. Covered topics include: problem-solving principles; object-oriented programming (classes and objects, control statements, functions, pointers, arrays, vectors, inheritance, polymorphism, exception handling, file processing, dynamic memory allocation); software engineering principles; basic data structures and algorithms: linked lists, recursion, sorting, and basic analysis of algorithms. Offered Every Term.
Prerequisites: MAT 2010 with a minimum grade of C-
Restriction(s): Enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

ECE 2610 Digital Logic Design Cr. 4
Data representation in digital computer; boolean algebra; logic gates; minimization and implementation of boolean functions; arithmetic circuits; combinational circuits; sequential circuits: latches and flip-flops; counters; finite state machines; memories; and Verilog programming. Laboratory experiments provide hands-on experience using state-of-the-art FPGA setup to simulate, implement, and test combinational and sequential logic circuits. Offered Every Term.
Prerequisites: (CSC 2000 with a minimum grade of C- (may be taken concurrently) or ECE 2050 with a minimum grade of C- (may be taken concurrently)) and PHY 2180 with a minimum grade of C- (may be taken concurrently)
Restriction(s): Enrollment is limited to Undergraduate level students.
Fees: $10

ECE 3040 Numerical Methods for Engineers Cr. 3
Developing numerical algorithms to provide solutions to engineering problems. Derivation of numerical algorithms and investigation of their stability, accuracy, efficiency and scalability. Programming numerical algorithms in Matlab. Topics include: Machine Round-off error, truncation error, root finding, solution of systems of linear and nonlinear algebraic equations, Taylor and Chebyshev series and rational function approximation, interpolation, regression, numerical differentiation, numerical integration, numerical solution of ordinary differential equations, and Monte Carlo methods. Offered Every Term.
Prerequisites: BE 1200 with a minimum grade of C-, BE 1500 with a minimum grade of C-, MAT 2030 with a minimum grade of C-, and (MAT 2150 with a minimum grade of C- (may be taken concurrently) or (MAT 2250 with a minimum grade of C- (may be taken concurrently) and MAT 2350 with a minimum grade of C- (may be taken concurrently)))
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $15

ECE 3300 Introduction to Electrical Circuits Cr. 4
Electrical quantities and waveforms; resistance and Ohm's law; networks and Kirchhoff's laws; network equivalents; nodal and mesh analysis; Thevenin's theorem and other network theorems. Analysis of First- and second-order systems in the time domain (employing differential equations) and in the s-domian (employing the Laplace transform method). Offered Every Term.
Prerequisites: PHY 2180 with a minimum grade of C- and (MAT 2150 with a minimum grade of C- (may be taken concurrently) or (MAT 2250 with a minimum grade of C- (may be taken concurrently) and MAT 2350 with a minimum grade of C- (may be taken concurrently)))
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $25

ECE 3320 Introduction to Electrical Circuits Cr. 4
Electrical signals and waveforms; resistance and Ohm's law; networks and Kirchhoff's laws; network equivalents; nodal and mesh analysis; Thevenin's theorem; energy storage systems; Introduction to sinusoidal steady-state response; complex frequency concepts; Frequency responses. No credit towards B.S. EE degree. Offered Every Term.
Prerequisites: PHY 2180 with a minimum grade of C- and MAT 2150 with a minimum grade of C- (may be taken concurrently)

ECE 3330 Electrical Circuits II Cr. 3
Sinusoidal steady-state response; AC steady-state power; three-phase systems; complex frequency concepts; frequency responses; resonant and coupled circuits; application of Fourier transforms, and Laplace transform to electrical circuits, and filter circuits. Offered Every Term.
Prerequisites: (MAT 2150 with a minimum grade of C- or (MAT 2250 with a minimum grade of C- and MAT 2350 with a minimum grade of C-)) and ECE 3300 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 3570 Electronics Cr. 4
DC and small signal analysis of diodes, MOSFETs, and BJTs circuits; operational amplifiers, single-stage amplifiers, differential pair, gain, input resistance, output resistance, and bandwidth of amplifiers. Offered Fall, Winter.
Prerequisites: ECE 3300 with a minimum grade of C- and ECE 3330 with a minimum grade of C- (may be taken concurrently)
Restriction(s): Enrollment limited to students in the College of Engineering.
Fees: $15

ECE 3620 Introduction to Microcomputers Cr. 4
Basics of digital systems, number systems, functional blocks of microcomputers, assembly language and machine code, applications of microcomputers and experimental demonstrations. Introduction to digital logic. Offered Fall, Winter.
Prerequisites: BE 1200 with a minimum grade of C- and (ECE 2610 with a minimum grade of C- or ECE 3610 with a minimum grade of C-)
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $25

ECE 4050 Algorithms and Data Structures Cr. 3
Introduction to problem solving methods and algorithm development; data abstraction for structures such as stacks, queues, linked lists, trees, and graphs; searching and sorting algorithms and their analysis. Offered Fall, Winter.
Prerequisites: (CSC 2000 with a minimum grade of C- or ECE 2050 with a minimum grade of C-) and MAT 2860 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 4330 Linear Systems and Signals Cr. 4
Content includes: continuous-time and discrete-time linear systems and signals; properties of linear systems; classical analysis methods and convolution; system analysis method for zero-state and zero-input response; Laplace transform and its application to linear system analysis; Fourier series expansion of periodic signals; Fourier transform and the steady-state response; application to analog filters, control and communication systems; solution of linear difference equations; z-transform analysis method; sampling theory; discrete-time Fourier transform and its application in digital filter design. Offered Fall, Winter.
Prerequisites: ECE 3330 with a minimum grade of C- and ECE 3040 with a minimum grade of C- (may be taken concurrently)
Restriction(s): Enrollment limited to students in the College of Engineering.

ECE 4331 Systems and Signals Laboratory Cr. 2
Experiments cover signal generation, signal manipulations and signal measurements, electronic oscillators, steady-state, zero-state and zero-input responses of linear circuits, harmonic sinusoidal content (Fourier Series) of periodic signals, low-pass, high-pass, band-pass and notch filter circuits, network functions, solution of differential equations using operational amplifier circuits, amplitude modulation and demodulation of speech signals, signal sampling and reconstruction. Offered Fall, Winter.
Prerequisites: ECE 4330 with a minimum grade of C- (may be taken concurrently)

ECE 4340 Microcomputer-Based Instrumentation Laboratory Cr. 2
Multipurpose personal-computer-based approach to real time instrumentation. Current interfacing and software used for data acquisition, transmission, analysis and report writing. Offered Fall, Winter.
Prerequisites: (ECE 2610 with a minimum grade of C- or ECE 3610 with a minimum grade of C-), ECE 3570 with a minimum grade of C-, and ECE 3330 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the College of Engineering.
Fees: $10

ECE 4470 Control Systems I Cr. 3
System representations; feedback characteristics; time-domain characteristics; Routh-Hurwitz criteria; Root Locus Plots; Nyquist criteria, Bode plots; PID, controller design. Offered Fall, Winter.
Prerequisite: ECE 4330 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 4570 Fundamentals of Microelectronic Devices Cr. 3
Fundamental aspects of semiconductor materials, nature of charge carriers in semiconductors, aspects of electrical properties of semiconductors, the physical electronics of P-N junction, MOSFET and bipolar field effect transistors, and device fabrication technology essential to understanding semiconductor active devices and integrated circuits. Introduction to optoelectronic devices including photovoltaic cells, light emitting devices, photodetectors, and solid-state lasers. Offered Every Term.
Prerequisites: ECE 3300 with a minimum grade of C- and (MAT 2150 with a minimum grade of C- or (MAT 2250 with a minimum grade of C- and MAT 2350 with a minimum grade of C-))
Restriction(s): Enrollment limited to students in the College of Engineering.

ECE 4600 Capstone Design I Cr. 4
Design principles, subsystems of microcontrollers; designing products using microcontrollers, sensors and actuators. Offered Fall, Winter.
Prerequisite: ENG 3050 with a minimum grade of C- and ECE 3620 with a minimum grade of C- and ECE 4330 with a minimum grade of C-
Restriction(s): Enrollment limited to students with a class of Senior; enrollment limited to students in the College of Engineering.

ECE 4680 Computer Architecture Cr. 3
An introduction to computer architecture. Instruction set architecture; performance analysis of computer systems; basic processor design and implementation techniques; pipelined processor design; design of the control unit, memory hierarchy and cache design; I/O. Offered Fall, Winter.
Prerequisites: BE 2100 with a minimum grade of C-, ECE 2610 with a minimum grade of C-, and ECE 3620 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the College of Engineering.

ECE 4700 Introduction to Communication Theory Cr. 4
Basic information transmission concepts. Spectral analysis. Transmission through linear networks. Sampling principles. Digital and analog communication signals and systems. The effect of noise in communication systems. Elementary decision theory. Offered Fall, Winter.
Prerequisite: (BE 2100 with a minimum grade of C- or BE 3220 with a minimum grade of C-) and ECE 4330 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the College of Engineering.

ECE 4800 Electromagnetic Fields and Waves I Cr. 3
Fundamentals of electromagnetic engineering, static electric and magnetic fields using vector analysis and fields of steady currents, Maxwell's equations and boundary value problems. Basic principles of plane waves, transmission lines and radiation. Offered Fall, Winter.
Prerequisite: ECE 3330 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 4850 Engineering Optics Cr. 3
Topics include: lightwave fundamentals, optical sources and detectors, optical fibers and waveguides, optical instrumentation, optical sensors for self-driving vehicles and robotics, applications optical devices and systems. Offered Yearly.
Prerequisite: ECE 3330 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the College of Engineering.

ECE 4990 Directed Study Cr. 1-4
Supervised study and instruction in a field selected by the student. Offered Every Term.
Restriction(s): Enrollment limited to students with a class of Senior; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Repeatable for 4 Credits

ECE 5100 Quantitative Physiology Cr. 4
Basic principles of human physiology presented from the engineering perspective. Bodily functions, their regulation and control discussed in quantitative terms and illustrated by mathematical models where feasible. Offered Every Term.
Equivalent: BME 5010, CHE 5100, ME 5100

ECE 5280 Introduction to Cyber-Physical Systems Cr. 3
Modeling, design, analysis, and implementation of cyber-physical systems; dynamic behavior modeling, state machine composition, and concurrent computation; sensors and actuators; embedded systems and networks; feedback control systems; temporal logic and model checking. Offered Yearly.
Prerequisites: CSC 2200 with a minimum grade of C
Restriction(s): Enrollment limited to students in the College of Engineering.
Equivalent: CSC 5280

ECE 5330 Modeling and Control of Power Electronics and Electric Vehicle Powertrains Cr. 3
This course will introduce basic methodologies for modeling, dynamic analysis, control system design, system coordination for electric vehicle powertrains. Course design projects will be required to develop design experience in the process of modeling, control design, and simulation involving batteries, power electronics, and electric machines. Offered Fall.
Prerequisites: ECE 4470 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate or Undergraduate level students; enrollment limited to students in the College of Engineering.

ECE 5340 Advanced Energy Storage Systems for Electrification of Vehicles Cr. 3
The objective of this course is to learn fundamentals of energy storage systems for electric-based transportation and to provide basic knowledge in the multidisciplinary field of energy storage devices and their applications for land, space and marine vehicles. The focus of the course will be on advanced batteries, supercapacitors, and fuel cells for transpiration applications; battery sizing and integration to various land-marine-space vehicles; and the fundamentals of battery management systems including various methodologies in electrical control and thermal management modes. Offered Intermittently.
Prerequisites: PHY 2180 with a minimum grade of C

ECE 5350 Alternative Energy Sources and Conversions Cr. 3
Covers the fundamentals of alternative energy sources and conversion of these sources to electrical energy. The focus will be on solar and wind energy sources, covering design and operation of photovoltaic cells, solar thermal technologies, and design and operation of wind towers and wind farms. Other topics include: principle operations of geothermal energy, nuclear power plants, hydro-power, tidal and ocean waves and various methods of capturing and transforming these energy resources to electricity. Offered Intermittently.
Prerequisites: PHY 2180 with a minimum grade of C

ECE 5410 Power Electronics and Control Cr. 3
Control of electrical energy using solid state devices, diodes, thyristors, IGBTs, and new WBG devices; mathematical analysis of circuits containing these devices; power converters and control; applications of power converters in alternative energy systems and electric vehicles. Offered Winter.
Prerequisites: ECE 4330 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the College of Engineering.
Equivalent: EVE 5410

ECE 5415 Smart Grid and Smart Systems Cr. 3
This course provides a comprehensive introduction to the multi-disciplinary field of smart grid and smart systems. It covers the application of artificial intelligence (AI) in the control and optimization of these systems. The first part of the course focuses on smart grid topics, including smart grid energy management and control, distributed energy resources, and demand response. The second part introduces several key smart systems used in today's industry, such as microgrids, smart buildings and smart homes. The principles underlying operation and control of these systems are introduced using basic electrical engineering knowledge. Offered Yearly.
Prerequisites: ECE 3300 with a minimum grade of C-

ECE 5425 Robotic Systems I Cr. 4
Introduction to robot kinematics and control. Computational algorithms for robot movement, sensor fusion, and intelligent behavior, which are needed to build a system that performs actions and interacts with its environment. Offered Winter.
Prerequisites: BE 1500 with a minimum grade of C-, BE 1600 with a minimum grade of C-, BME 5020 with a minimum grade of C-, or ECE 3040 with a minimum grade of C-
Equivalent: BME 5425

ECE 5430 Electric Energy Systems Engineering Cr. 3
Transmission capacity, load characteristics, reactive power compensation. Energy system component analysis and modeling. Steady-state analysis, load-flow problem and algorithms. Balanced fault analysis, symmetrical components and unbalanced fault analysis, and power system protection. Offered Intermittently.
Prerequisites: ECE 4330 with a minimum grade of C-

ECE 5440 Traditional and Machine Learning-Based Computer-Controlled Systems Cr. 3
Introduction to z-transform and sampling theory. Digital controller design using both transfer function techniques and state space methods. Iterative learning control, neural networks for control, implementation aspects of computer-controlled systems. Offered Yearly.
Prerequisites: ECE 4470 with a minimum grade of C-, CHE 4600 with a minimum grade of C-, or ME 5540 with a minimum grade of C-

ECE 5470 Control Systems II Cr. 3
State space representation of systems; stability and Lyapunov methods, controllability and observability of linear time-invariant systems, pole placement design using state feedback, observer design, optimal control, linear quadratic regulators, Kalman filter. Offered Yearly.
Prerequisites: ECE 4470 with a minimum grade of C-

ECE 5550 Solid State Electronics Cr. 3
Physical basis for the opto-electric properties of solids with particular emphasis on semiconductors. Basic principles associated with solid-state devices. Charge carriers and mechanisms of current flow. Extrinsic and intrinsic semiconductors. Behavior of P-N junctions, field-effect, and bipolar transistors. Computer-aided simulation of device characteristics. Course project related to contemporary topics in semiconductors. Offered Fall.
Prerequisites: ECE 4800 with a minimum grade of C- and ECE 4570 with a minimum grade of C-

ECE 5560 Analysis and Design of Analog Integrated Circuits Cr. 3
The course provides students the fundamentals in Large-Signal/Small-Signal Transistor Modeling, Single-Stage Amplifier Design, Noise, Feedback, Current Mirrors, Differential Amplifiers, Stability, and Frequency Response, Mismatch and Nonlinearity, OpAmp Design, and CAD Tool. Cadence design suite will provide state-of-the-art hands-on experience to analyze, design, and simulate analog circuits. Advanced topics, including Analog and Mixed-Signal Artificial Neural Networks. Offered Fall.
Prerequisites: ECE 3330 with a minimum grade of C- and ECE 3570 with a minimum grade of C-

ECE 5575 Introduction to Micro and Nano Electro Mechanical Systems (MEMS/NEMS) Cr. 3
General and specialized micro/nanofabrication techniques; basic sensing and actuating mechanisms (piezoresistive, piezoelectric, capacitive, electrostatic, thermal pneumatic, etc.); and design and operation of various MEMS/NEMS devices for automotive and biomedical applications; fabrication and characterization of basic MEMS structures. Offered Fall.
Prerequisites: ECE 4570 with a minimum grade of C-

ECE 5580 Advanced Nanoelectronics Cr. 3
This course will provide an overview of next generation nanoelectronic devices, with a focus on device operation principles, technology scaling trends, and manufacturing techniques. Course will start with the evolution of MOSFET technology enabled by unprecedented advances in materials, manufacturing techniques and device architecture innovations. Different transistor technologies (i.e. HEMT, TFET) and novel electronic materials beyond Si (i.e. III-Vs, 2D materials, Carbon Nanotubes) will be covered. Following the overview of different memory device technologies, the focus will be shifted to novel computing paradigms. Device technologies that enable neuromorphic and quantum computing, associated fabrication challenges and innovative computation algorithms will be reviewed. Offered Winter.

ECE 5590 Characterization and Applications of Semiconductor Devices Cr. 1
This course focuses on (1) measuring and characterizing basic common semiconductor device components and (2) building and demonstrating simple circuits with them. Common devices studied include diode, transistor, LED, laser, solar cell, etc. The goals are to provide students with hands-on experience, understanding the applications of basic devices, and an overall knowledge of the semiconductor industry. This general semiconductor lab course is suited for a wide audience of all departments in engineering, both graduates and undergraduates. Offered Fall, Winter.

ECE 5610 Introduction to Parallel and Distributed Systems Cr. 3
Fundamentals of parallels and distributed systems. Programming experience in both computing environments. Offered Yearly.

ECE 5620 Embedded System Design Cr. 4
Microcontroller architecture and its subsystems. Wired and wireless protocols for vehicular networking applications. Design and implementation of real-time embedded systems. Offered Fall, Winter.
Prerequisites: ECE 3620 with a minimum grade of C-

ECE 5650 Computer Networking and Network Programming Cr. 3
Overview of networks and the Internet, the application layer, socket programming, the transport Layer, the network Layer, the link Layer: links, access networks, and LANs. Introduction to Software-Defined networking, OpenFlow, and wireless and mobile networks. Projects provide students with hands-on experience in developing network applications. Labs provides students with hands-on experience with network layers and protocols. Offered Every Other Winter.
Prerequisites: ECE 4050 with a minimum grade of C-

ECE 5675 Sensors and Sensor Instrumentation Cr. 3
Provides students both theoretical background and hands-on skills of sensors and sensor instrumentation, and to prepare students for researches and careers involving sensors and instrumentation. The topics include operating principles of typical sensors, sensing mechanisms (piezoresistive, piezoelectric, capacitive, etc.); sensor instrumentation, amplifiers, noise analysis, and frequency response of readout circuits. Offered Winter.
Prerequisites: ECE 3570 with a minimum grade of C-

ECE 5680 Computer-Aided Logical Design and FPGAs Cr. 4
Topics include: review of digital design; advanced applications of Boolean algebra techniques; Computer-Aided Logical Design for large Boolean functions and simplification; threshold function; linear sequential machines; design using Verilog and FPGAs; introduction to cadence. Offered Winter.
Prerequisites: ECE 4680 with a minimum grade of C-

ECE 5690 Introduction to Digital Image Processing Cr. 4
Provide college engineering seniors and graduate students with an introduction to basic concepts and methodologies appliable to digital image processing from an operational perspective with good exposure to theory, accessibility of DIP to engineering, and to develop a foundation that can be used as the basis for further study and research in this field. Includes a detailed review of current techniques in this field, and their applications to different aspects such as 2-D, 3-D information processing, storage, transmission, extraction of information, medical images, life science, automation, and various industrial sectors, etc. It is the basis for machine learning and AI related fields. Imaging sensors and imaging systems are also covered. Tools to be used include mathematical analysis, vectors, matrices, probability, statistics, sequences and series, and computer programming. Offered Fall.
Prerequisites: ECE 4050 with a minimum grade of C-, ECE 4330 with a minimum grade of C-, and BE 2100 with a minimum grade of C-

ECE 5700 Digital Communications Cr. 4
Digital modulators and demodulators, M-ary PSK, M-ary FSK, optimal receiver for AWGN channel. correlator receiver, matched filter receiver, analysis of probability of bit errors for digital communication systems, Shannon limit, simulation of digital communication system. Offered Fall.
Prerequisites: ECE 4700 with a minimum grade of C-

ECE 5770 Digital Signal Processing Cr. 4
Analysis of discrete signals and systems. Applications to digital filtering, active filters, digital communication and encoding. Offered Yearly.
Prerequisites: ECE 4700 with a minimum grade of C-

ECE 5880 Introduction to Microwave Engineering Cr. 4
Introduces students to microwave engineering and prepares them for careers in wireless communications, radars and remote sensing. Topics that will be covered include microstrip lines, coplanar waveguides, scattering parameters, impedance matching, microwave filters, power dividers and directional couplers, nonreciprocal devices, mixers and amplifiers. Offered Yearly.
Prerequisites: ECE 4800 with a minimum grade of C- (may be taken concurrently)

ECE 5960 Introduction to VLSI Systems Cr. 4
A very large scale integrated circuit component and design procedures. MOS fabrication, MOS gates, circuit architecture, device design, manufacturing and interface techniques. Offered Fall.
Prerequisites: ECE 2610 with a minimum grade of C-
Fees: $30

ECE 5990 Directed Study Cr. 1-3
Supervised study and instruction in the field selected by the student. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students; enrollment is limited to students in the Department of Electrical & Computer Engineer.
Repeatable for 3 Credits

ECE 5995 Special Topics in Electrical and Computer Engineering I Cr. 1-4
Special subject matter in electrical and computer engineering. Topics to be announced in Schedule of Classes . Offered Every Term.
Repeatable for 8 Credits

ECE 6570 Smart Sensor Technology I: Design Cr. 3
Introduction to various types of sensors and the design of basic analog VLSI circuit building blocks. Offered Winter.
Prerequisites: PHY 2185 with a minimum grade of C- or PHY 2180 with a minimum grade of C-
Equivalent: BME 6470, PHY 6570

ECE 6991 Industrial Internship Cr. 1-3
Internship experience that satisfies the curricular practical training requirements. Offered for graduate credit only. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 3 Credits

ECE 6992 Industrial Internship Cr. 1-3
Internship experience that satisfies the curricular practical training requirements. Offered for graduate credit only. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 6 Credits

ECE 7030 Mathematical Methods in Engineering I Cr. 4
Introduction to functional analysis. Banach and Hilbert spaces. Fixed-point and projection theorem techniques. Approximation, estimation, and optimization theory. Applications to numerical and error analysis, non-linear equations, and modeling system identification. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7100 Mathematical Modeling in Impact Biomechanics Cr. 4
Review of models created for impact simulations. Regional impact simulation models. Human and dummy models subject to various restraint systems. Offered Intermittently.
Prerequisite: BME 5010 with a minimum grade of B-
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: BME 7100, IE 7100, ME 7100

ECE 7420 Nonlinear Control Systems Cr. 3
This course will develop models for nonlinear dynamical systems, perform system analysis using phase plane analysis, and examine stability using Lyapunov's direct method and invariant set theorems (local and global stability). It will introduce describing function methods and design nonlinear robust controllers by using sliding mode control. Offered Fall.
Prerequisite: ECE 5470 with a minimum grade of B- or ME 6550 with a minimum grade of B-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ECE 7425 Robotics Systems II Cr. 4
Project-based class to understand technology that interfaces computer engineering, software design, electronics and sensors with robotics. We will cover Robot Operating System simulation and real. Advanced application areas of robotics will be covered including medical, military, space, vehicle robotics. Completion of ECE/BME#5425#Robotic Systems I is recommended prior to registering for this course. Offered Every Other Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Equivalent: BME 7425

ECE 7430 Discrete Event Systems with Machine Learning Cr. 4
Discrete event systems and fuzzy discrete event systems; automata and fuzzy automata; supervised learning; languages and operations; supervisory control; controllability, observability, and co-observability, modular control and decentralized control, supervisor synthesis. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7440 Optimal Control with Machine Learning and Applications Cr. 3
This course will develop competence in analysis and design of optimal control systems with machine-learning algorithms and applications. Formulation of optimization and optimal control problems. Traditional and machine-learning algorithms for optimization. Optimal control design methods in continuous-time systems. Optimal control with boundary constraints. Offered Intermittently.
Prerequisite: ECE 5440 with a minimum grade of B- or ECE 5470 with a minimum grade of B- or ME 5550 with a minimum grade of B-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ECE 7500 Artificial Intelligence for Natural Language Processing Cr. 3
Natural Language Processing (NLP) is a field in Artificial Intelligence (AI) devoted to creating computer systems that understand and produce human languages. This course will present a broad graduate-level introduction to NLP. We will focus on fundamental methods and algorithms/techniques in NLP. We will also explore several NLP applications, such as sentiment analysis, information extraction, syntactic parsing, and semantic analysis. Additionally, the course will introduce state-of-the-art transformer models, which have revolutionized NLP by enabling advanced language understanding and generation. We will discuss their architectures, training methodologies, and real-world applications, providing hands-on experience with cutting-edge techniques in deep learning for NLP. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7530 Advanced Digital VLSI Design Cr. 4
Topics include: review of VLSI Design processes; CADENCE tools used to simulate and generate the schematic and layout of the synthesized hardware description language codes; and chip fabrication. Offered Winter.
Prerequisites: ECE 5680 with a minimum grade of C and ECE 5960 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7566 Advanced Mixed Signal Integrated Circuits Cr. 3
the course presents advanced topics in CMOS mixed signal integrated circuits including analysis and design of low power digital to analog (D/A) and analog to digital converters (A/D) , comparators, sample and hold circuits, band gap references and switched-capacitor circuits. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7570 Smart Sensor Technology II: Characterization and Fabrication Cr. 4
Integration of ongoing research in integrated technology of smart sensors. Design of smart sensor devices using computer simulation. Fabrication of smart sensor. Offered Spring/Summer.
Prerequisite: ECE 6570 with a minimum grade of B- or BME 6470 with a minimum grade of B- or PHY 6570 with a minimum grade of B-
Restriction(s): Enrollment is limited to Graduate level students.
Fees: $50
Equivalent: BME 7470, PHY 7580

ECE 7610 Advanced Parallel and Distributed Systems Cr. 3
Advanced topics in parallel and distributed computing, multicore and parallel architecture, communication, synchronization, parallel algorithms and programming, load balancing and scheduling, security. Offered Winter.
Prerequisite: ECE 5610 or ECE 5650
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7640 Online and Adaptive Methods for Machine Learning Cr. 3
Introduction to state-of-the-art online and adaptive algorithms with an emphasis on algorithm design and theoretical analysis. It will cover graduate-level advanced topics including online convex optimization, bandits, reinforcement learning as well as applications in training large language models like ChatGPT. Offered Intermittently.
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7650 Scalable and Secure Internet Services and Architecture Cr. 3
Advanced principles of distributed and cloud computing systems, Internet servers and data centers, content delivery networks, software-defined networking, Internet of things, multimedia networking, performance scalability, energy-aware resource management, security, cost-effective engineering design. Offered Every Other Year.
Prerequisite: ECE 5610 with a minimum grade of C or ECE 5650 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7680 Advanced Digital Image Processing and Applications Cr. 4
Advanced aspects, algorithms, methods in digital image processing and their corresponding applications in different fields, and key elements for machine learning and AI. Students develop comprehensive skills and knowledge in digital image processing. Offered Yearly.
Prerequisite: ECE 5690 with a minimum grade of B-
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7690 Fuzzy Systems and Machine Learning Cr. 3
Major topics covered in this course include: fuzzy sets, fuzzy logic, fuzzy inference, fuzzy rule-based systems, fuzzy model identification, fuzzy control, fuzzy data clustering algorithms, optimization, genetic algorithms, neural networks, supervised learning algorithms, adaptive neuro-fuzzy inference systems, deep learning, convolutional neural networks, long short-term memory models, Markov decision processes, reinforcement learning. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7700 Statistical Communication Theory Cr. 4
Decision theory, binary decisions with single and multiple observations, signals in additive Gaussian noise, sequential decision theory, estimation theory, Kalmon filtering. Offered Yearly.
Prerequisite: ECE 5700 with a minimum grade of B-
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7730 Telematics Cr. 4
Introduction to automotive telematics, mobile communication channels, error correction, automatic crash response, vehicle diagnostics, vehicle tracking, vehicle safety, navigation, and current topics in telematics. Offered Winter.
Prerequisite: ECE 5700 with a minimum grade of B-
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7820 Electricity Market Cr. 3
Advanced electric energy system economics. Principles of energy system modeling and analysis. Electric energy industry structure and the economic issues concerning electricity generation, transmission, and distribution. Emphasis on renewable energy and smart grids, and consumer empowerment as market architecture drivers. Offered Fall.
Prerequisites: ECE 3330 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7850 Photonics Cr. 4
Topics include: light-matter interaction using the concepts of rays, electromagnetic waves, and quanta of light; electronic and photonic properties of materials; photonic devices for applications in communication, signal processing, data storage, and sensing; photonic solutions for quantum technologies in cryptography, communication, and computing. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7860 Operation and Control of Modern Power Systems Cr. 3
Topics include power system optimal dispatch; power system stability analysis and control; smart grid technologies and applications, covering modeling and control of renewable energy systems; distributed generation; microgrid architecture and control; demand response; energy storage for power grids; grid interface and integration of renewable sources; and electricity market fundamentals. Offered Fall.
Prerequisite: ECE 5430 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7990 Directed Study Cr. 1-8
Supervised study and instruction in an advanced topic. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

ECE 7995 Special Topics in Electrical and Computer Engineering II Cr. 1-4
A consideration of special subject matter in electrical and computer engineering. Topics to be announced in Schedule of Classes . Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

ECE 7996 Research Cr. 1-8
Design, investigation and experimental work on some phase of electrical and computer engineering. Written report required. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 8 Credits

ECE 8999 Master's Thesis Research and Direction Cr. 1-6
Offered Every Term.
Restriction(s): Enrollment limited to students with a class of Candidate Masters; enrollment is limited to Graduate level students.
Repeatable for 6 Credits

ECE 9990 Pre-Doctoral Candidacy Research Cr. 1-8
Research in preparation for doctoral dissertation. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

ECE 9991 Doctoral Candidate Status I: Dissertation Research and Direction Cr. 3-9
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 9 Credits

ECE 9992 Doctoral Candidate Status II: Dissertation Research and Direction Cr. 1-18
Offered Every Term.
Prerequisite: ECE 9991 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 18 Credits

ECE 9994 Doctoral Candidate Status IV: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Prerequisite: ECE 9993 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.

ECE 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction Cr. 0
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 0 Credits

ECE 9997 Doctoral Seminar Cr. 1-4
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 4 Credits