ECE - Electrical and Computer Engineering

Courses numbered 100 to 299 = *lower-division*; 300 to 499 = *upper-division;* 500 to 799 = *undergraduate/graduate*.

ECE 115. ECE Freshman Seminar (0).
Aims to provide an introduction to electrical and computer engineering. Most of the meetings have industry speakers sharing their experience and providing information about the required preparation.

ECE 194. Introduction to Digital Design (4).
Introduces digital design concepts. Includes number systems, Boolean algebra, Karnaugh maps, combinational circuit design, adders, multiplexers, decoders, sequential circuit design, state diagram, flip flops, sequence detectors and test different combinational and sequential circuits. Uses CAD tools for circuit simulation. Prerequisite(s): MATH 111 or equivalent. Corequisite(s): ECE 194L.

ECE 238. Assembly Language Programming for Engineers (3).
Introduces basic concepts of computer organization and operation. Studies machine and assembly language programming concepts that illustrate basic principles and techniques. Laboratory exercises given for experience using personal computers. Prerequisite(s): CS 211.

ECE 281I. Noncredit Internship (0).
Complements and enhances the student's academic program by providing an opportunity to apply and acquire knowledge in a workplace environment as an intern. Prerequisite(s): departmental consent.

ECE 282. Circuits I (4).
Electric circuit principles and methods of analysis. Includes DC circuits, network theorems, capacitance and inductance, AC circuit analysis, phasor plane techniques, complex power, and balanced three-phase circuits. Pre- or corequisite(s): MATH 243. Corequisite(s): ECE 282L.

ECE 284. Circuits II (3).
Includes circuits with mutually coupled elements, transfer functions emphasizing frequency response, two-port networks, Laplace transforms and application to transient circuit analysis, and the application of computer-aided analysis software toward circuit analysis and design. Prerequisite(s): ECE 282 and MATH 243. Pre- or corequisite(s): MATH 555.

ECE 285L. Programming with MATLAB for Electrical and Computer Engineers (1).
Develops a deeper understanding of electrical and computer engineering related programming and analysis. MATLAB is a strong high-level programming language which is popular in science and engineering fields. Once a student learns to develop solutions to electrical and computer engineering problems using MATLAB, the programming skills can be easily extended to other programming languages. These skills are critical for both industry and graduate studies. Course covers visualization, developing and solving equations for electrical and computer engineering, symbolic toolboxes, and advanced programming methods for electrical and computer engineering applications. Prerequisite(s): CS 211. Pre- or corequisite(s): ECE 284.

ECE 338. FPGA-Based System Design (4).
Introduces digital design concepts using field programmable gate arrays (FPGAs). Includes programmable logic devices, FPGA architecture, interconnect, digital design challenges, digital design process, and integrated circuit fabrication process. Presents digital design flow using FPGAs, and other technologies associated with field programmable gate arrays. Introduces the concept of Verilog programming. Uses CAD tool for circuit simulation. Prerequisite(s): ECE 194 and CS 211. Corequisite(s): ECE 338L.

ECE 346. Introduction to Computer Networks (3).
Cross-listed as CS 346, AC 346. Introductory course on computer networking. Introduces concepts, protocols and security in various network layers with emphasis on applications, transport layer (TCP, UDP), network layer (ICMP), and link layer. All concepts in the course are reinforced though hands-on assignments. Prerequisite(s): CS 211.

ECE 383. Signals and Systems (3).
Properties of signals and systems, convolution and its application to system response, Fourier series representation of periodic signals, Fourier transforms and continuous spectra, filters, time domain sampling and Z-transforms. Many of these topics include discrete as well as continuous systems. Prerequisite(s): ECE 284, ECE 285L and MATH 555.

ECE 394. Introduction to Computer Architecture (3).
Introduces multilevel approach to computer systems, with an emphasis on micro architecture and instruction set architecture levels. Also introduces techniques to improve performance such as cache memory and instruction level parallelism. Prerequisite(s): ECE 194 and CS 211.

ECE 395. Embedded Systems and Internet of Things (2).
Introduces the basic concepts of embedded and Internet of Things (IoT) systems. This course helps increase understanding of electronic devices interfaced with networks. Teaches how to program popular contemporary microcontrollers that are used in cloud computing. Laboratory and team-project activities give hands-on experience. Prerequisite(s): ECE 194, CS 211 .

ECE 463. Applied Engineering Electromagnetics (3).
Maxwell's equations in integral and differential form. Transient and steady state response of circuits containing transmission lines with emphasis on applications in communications and digital electronics. Additional topics in optics and electromagnetic radiation as time permits. Prerequisite(s): MATH 344, PHYS 314 and CHEM 211.

ECE 475. Modeling, Simulation and Analysis (2).
Introduces basic concepts of modeling and simulation using popular simulation tools. Presents method to analyze simulated results for making useful decisions. Laboratory and team-project activities give hands-on experience. Special attention are given to various computer and electrical engineering applications. This course has a lab component. Prerequisite(s): ECE 395.

ECE 477. Special Topics in Electrical Engineering (1-4).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 477A, 477B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

ECE 477N. Cloud Computing Architecture (3).
Cloud computing architecture uses a multilevel approach to the design process and introduces the fundamental components related to cloud based services and data centers. Emphasis is on the efficient use of computer, storage and networking resources to meet design requirements. Prerequisite(s): ECE 194.

ECE 477O. Semiconductor Devices (3).
Covers the device physics and device applications: fundamentals semiconductor device physics associated with semiconductor devices and in-depth understanding of p/n junction diodes, bipolar junction transistors and junction field effect transistors. Prerequisite(s): MATH 243.

ECE 481. Cooperative Education (1).
Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Repeatable for credit. Prerequisite(s): departmental consent.

ECE 481A. Cooperative Education (1).
Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Intended for students who are working full time on their co-op assignments and do not need to be enrolled in any other course. Repeatable for credit. Prerequisite(s): departmental consent.

ECE 481I. Noncredit Internship (0).
Complements and enhances the student's academic program by providing an opportunity to apply and acquire knowledge in a workplace environment as an intern. Repeatable. Prerequisite(s): departmental consent.

ECE 481P. Cooperative Education (1).
Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Students must enroll concurrently in a minimum of 6 credit hours of coursework including this course in addition to a minimum of 20 hours per week at their co-op assignments. Repeatable for credit. Prerequisite(s): departmental consent.

ECE 485. Introduction of Engineering Design Process (2).
Teaches students engineering design process with the focus on electrical and computer engineering. Students develop an interdisciplinary, fundamental, hands-on solution by applying design principles. Students are introduced to understanding the consumer needs, verifying design requirements, ethical responsibilities and safety, economic and environmental impacts, documenting, and functional design prototypes. Students completing this course should have the necessary skills and confidante to complete real projects. This course has a lab component. Prerequisite(s): ECE 492 and ECE 475.

ECE 488. Electric Machines and Transformers (4).
Theory and analysis of transformers, DC machines and AC machines. Includes single-phase and three-phase transformers, DC machines, synchronous machines and induction motors. Prerequisite(s): ECE 282. Corequisite(s): ECE 488L.

ECE 490. Independent Study/Research in ECE (1-3).
Arranged individual, independent study in specialized content areas in electrical engineering or computer engineering under the supervision of a faculty member.

ECE 492. Electronic Circuits I (4).
Introduces semiconductor devices and applications in discrete and integrated circuit design. Applications include, but are not limited to, op-amp circuits, rectification and transistor amplifiers. Pre- or corequisite(s): ECE 284, ECE 285L and PHYS 314. Corequisite(s): ECE 492L.

ECE 493. Electronic Circuit II (4).
Investigates the theory and application of discrete and integrated circuits. Includes op-amp construction, frequency response, feedback and stability, power amplifiers, and nonlinear integrated circuits. Prerequisite(s): ECE 492. Corequisite(s): ECE 493L.

ECE 577F. Artificial Intelligence for Cyber Physical System (3).
Emphasizes learning algorithms and theory including supervised and unsupervised learning, neural network, reinforcement learning, and applications to cyber physical system. Prerequisite(s): IME 254.

ECE 577G. Introduction to Error Control Coding (3).
Introduces the student to the fundamentals of error-correcting codes and their applications in communications and data storage systems. The goal is to develop the ability to design and analyze classical and modern methods of error-control coding. Prerequisite(s): MATH 511 and IME 254 (or their equivalents).

ECE 577M. Controlled and Autonomous Vehicle Networks (3).
Delves into the foundational concepts and advanced technologies shaping the landscape of Controlled Area Network (CAN) and the transformative field of autonomous and connected vehicles. Students explore the evolution from traditional vehicular communication systems to the sophisticated 5G NR C-V2X technology, gaining insights into the principles, protocols and applications that drive Intelligent Transportation Systems (ITS). The course provides a comprehensive understanding of CAN protocols, their role in vehicular communication, and their integration into autonomous and connected vehicle networks. Prerequisite(s): CS 211. Pre- or corequisite(s): CS 664.

ECE 585. Senior Design Project I (2).
Cross-listed as CS 598. Design project under faculty supervision chosen according to the student's interest. Does not count toward a graduate degree in electrical engineering, computer engineering or computer science. This class should be taken in the semester prior to the one in which the student is going to graduate. For undergraduate credit only. Prerequisite(s): senior standing, ECE 492 or CS 580. Pre- or corequisite(s): PHIL 354 or PHIL 385.

ECE 586. Introduction to Communication Systems (4).
Introduces data communication fundamentals from a signal processing perspective, focusing on the complex pulse amplitude modulation approach used in most commercial wireless systems. Describes specific receiver algorithms (MPAM, MQAM, MPSK, MFSK) for implementing wireless communication links, including synchronization, carrier frequency offset estimation, channel estimation and equalization. While most concepts are presented for systems with single transmit and receive antennas, concludes by extending those concepts to contemporary multiple-input multiple-output (MIMO) systems. Does not require prior courses on analog or digital communication. Prerequisite(s): ECE 383 and either STAT 471 or IME 254. Corequisite(s): ECE 586L.

ECE 588. Advanced Electric Motors (3).
Advanced electric motor applications and theory. Includes single-phase motors, adjustable speed AC drive applications and stepper motors. Prerequisite(s): ECE 488.

ECE 594. Microprocessor System Design (4).
Presents knowledge and skills required to design and program microprocessor-based systems. Introduces vendor-supplied special-purpose chips such as interrupt controllers and programmable input/output devices. Laboratory activities give hands-on experience. Prerequisite(s): ECE 238, 394. Corequisite(s): ECE 594L.

ECE 595. Senior Design Project II (2).
Does not count toward a graduate degree in electrical engineering, computer engineering or computer science. This is the second part of a sequence of two courses (ECE 585/CS 598 and ECE 595/CS 599) that have to be taken in two consecutive semesters. Students failing this course must retake the ECE 585/CS 598 course. For undergraduate credit only. Prerequisite(s): ECE 585 or CS 598.

ECE 596. Renewable Energy Engineering (3).
Analysis and design of renewable energy systems, including solar, wind, hydroelectric, geothermal and biomass systems. Analysis and design of energy storage systems that integrate with renewable energy

systems. Integration of renewable energy systems with the electric power supply system. Prerequisite(s): ECE 282 or APEN 320.

ECE 598. Electric Power Systems Analysis (3).
Analysis of electric utility power systems. Topics include analysis and modeling of power transmission lines and transformers, power flow analysis and software, and introduces symmetrical components. Prerequisite(s): ECE 488.

ECE 684. Introductory Control System Concepts (3).
Introduces system modeling and simulation, dynamic response, feedback theory, stability criteria, and compensation design. Prerequisite(s): ECE 282 and MATH 555, or ECE 383.

ECE 688. Power Electronics (4).
Deals with the applications of solid-state electronics for the control and conversion of electric power. Gives an overview of the role of the thyristor in power electronics application and establishes the theory, characteristics and protection of the thyristor. Presents controlled rectification, static frequency conversion by means of the DC link-converter and the cyclo converter, emphasizing frequency, and voltage control and harmonic reduction techniques. Also presents requirements of forced commutation methods as applied to AC-DC control and firing circuit requirement and methods. Introduces applications of power electronics to control AC and DC motors using new methods such as microprocessor. Prerequisite(s): ECE 383, 488, 492. Corequisite(s): ECE 688L.

ECE 694. High Performance Computer Systems (3).
Introduces modern high performance computer systems that are built using multicore central processing unit (CPU) and many-core graphics processing unit (GPU) architectures. Special attention is given to the cache-memory hierarchy of CPU/GPU and multithreading. Projects focus on contemporary scholarly activities and help students develop teamwork skills. Prerequisite(s): ECE 394 or instructor's consent.

ECE 696. Hardware-Based Cybersecurity (3).
Intended for seniors and graduate students who want to study and explore the role of hardware in improving security for critical systems and sensitive data. Topics covered include elements of computer security, hardware as a cybersecurity solution, physical unclonable function, secure distributed systems, and security engineering. Special attention is given to team-based research activities. Prerequisite(s): ECE 394 or instructor's consent.

ECE 697. Electric Power Systems Analysis II (3).
Analysis, design, modeling and simulation of high-voltage electric power transmission systems and rotating generators. Simulations include short circuit studies, economic dispatch and transient stability. Prerequisite(s): ECE 598.

ECE 707. Machine Learning Essentials and Applications (3).
Presents essential principles, theories and methodologies pivotal to machine learning and its implementations. Important topics include training, development and testing machine learning classification models; analysis of model accuracy considering datasets, bias and variance; and utilization of TensorFlow library for artificial neural networks and deep neural networks. Team activities and projects give hands-on experience. Pre- or corequisite(s): IME 254 and CS 211.

ECE 711. Optimization Techniques for Cyber-Physical Systems (3).
Aims to provide necessary theory and methods to solve optimization problems with the emphasis on cyber and physical systems. Integration of computation, communication and physical systems to improve engineered systems requires understanding of basic optimization techniques and advanced optimization algorithms. Covers basic optimization theory, convex optimization, heuristic optimization techniques, constraint relaxation and applications. Prerequisite(s): MATH 511 and MATH 555; or graduate standing.

ECE 726. Digital Communications Systems I (3).
Presents the theoretical and practical aspects of digital and data communication systems. Includes the modeling and analysis of information sources as discrete processes; basic source and channel coding; multiplexing and framing; spectral and time domain considerations related to ASK, PSK, DPSK, QPSK, FSK, MSK and other techniques appropriate for communicating digital information in both base-band and band-pass systems; intersymbol interference; effects of noise on system performance; optimum systems; and general M-ary digital systems in signal-space. Prerequisite(s): ECE 586 and 754.

ECE 737. Wireless Networking (3).
Cross-listed as CS 737. Covers topics ranging from physical layer to application layer in the wireless and mobile networking fields. Explores physical layer issues of wireless communications, wireless cellular telephony, ad-hoc networks, mobile IP and multicast, wireless LAN (IEEE 802.11), security, Bluetooth and WAP, etc. Imparts general knowledge about wireless communication technologies and ongoing research activities. Prerequisite(s): CS 664.

ECE 754. Probabilistic Methods in Systems (3).
Covers random processes designed to prepare the student for work in communications controls, computer systems information theory and signal processing. Covers basic concepts and useful analytical tools for engineering problems involving discrete and continuous-time random processes. Discusses applications to system analysis and identification, analog and digital signal processing, data compression parameter estimation, and related disciplines. Prerequisite(s): ECE 383 and IME 254.

ECE 777AA. Introduction to Transportation Electrification (3).
Provides an introduction to transportation electrification. Introduces the following vehicle fundamentals, vehicle performance, electric propulsion systems, energy storage and future of transportation electrification.

ECE 777AC. Data-Driven Decisions in Cyber-Physical Systems (3).
An introduction to new cyber-physical systems such as an autonomous vehicle and the smart city, where data has become very important for adaptive operations and with an increased dependence on information and communication technologies (ICT). Topics in the course are focused on new methods in the intersection of computer science and other domains, to support distributed operations, cyber security and processing of data that are generated due to digitalization of these systems (considering that the data can be massive). Prerequisite(s): IME 254 or equivalent.

ECE 777AD. Electric Machines for Transportation Electrification (3).
Focuses on basics of electric motors, placing an emphasis on traction drives. This class covers operating characteristics of synchronous machines, dc machines, brushless DC motors, stepper motors and transient characteristics of machines. This class also introduces electrical safety, protection and motor selection for different applications. Prerequisite(s): ECE 488 or ECE 777AA.

ECE 777AE. Characterization and Modeling of Batteries (3).
Presents a general overview of characterization and modeling of rechargeable lithium-ion batteries for transportation, grid storage, portable and aviation applications. During the course, derivation of mathematical models of the electrochemical dynamics of battery cells, including thermodynamic and kinematic properties at multiple

scales, are conducted. Modern lithium-ion chemistries are emphasized. Prerequisite(s): MATH 344, ECE 284 and MATH 555.

ECE 777AF. Controls, Communication and Storage for Transportation Electrification (3).
Presents a general overview of control theory and provides deeper knowledge in control applications such as optimal control and digital control. This course also introduces basic networking and cybersecurity issues related to vehicular communications. Battery maintenance and challenges for grid connection are also introduced in this class. Prerequisite(s): ECE 284, MATH 555, MATH 511.

ECE 777AG. Semiconductor Physics and Devices (3).
Covers the device physics and device applications: fundamentals semiconductor device physics associated with semiconductor devices and in-depth understanding of p/n junction diodes, bipolar junction transistors and junction field effect transistors. Prerequisite(s): PHYS 314, MATH 344.

ECE 777AI. Introduction to Semiconductor Packaging (3).
Explores the intersection of microelectronics, nanoelectronics and semiconductor packaging. Covers the advancement of electronic devices through transistor scaling, with a focus on feature sizes and integrated circuits. Students delve into historical trends, such as Moore’s Law, and understand the critical role of packaging in modern electronics. The course details the anatomy and function of semiconductor packages, from substrate-level interconnections to the motherboard, highlighting materials, design and reliability considerations. Prerequisite(s): ECE 477O and ECE 492, or graduate standing.

ECE 777G. Data Communication Analysis I (3).
Presents analysis and practice of data communications. Includes the data channel analysis, e.g., pathloss, shadow fading, outage probability and data cell coverage area. Presents new trend in data modulation and demodulation for terrestrial and satellite communications, e.g., MASK, MPSK, MFSK, MQAM, MAPSK, OFDM in both baseband and bandpass systems. Presents performance analysis of data communications over additive white Gaussian noise (AWGN) and fading channels, e.g., analysis on bit error rate (BER), symbol error rate (SER), packet error rate (PER) and channel capacity such as bandwidth efficiency in bits/second/Hz and outage probability. Prerequisite(s): ECE 586. Pre- or corequisite(s): ECE 754.

ECE 782. Digital Signal Processing (3).
Presents the fundamental concepts and techniques of digital signal processing. Time domain operations and techniques include difference equations and convolution summation. Covers Z-transform methods, frequency-domain analysis of discrete-time signals and systems, discrete Fourier transform, and fast Fourier transform. Emphasizes the frequency response of discrete-time systems and the relationship to analog systems. Prerequisite(s): ECE 383.

ECE 784. Digital Control Systems (3).
Studies the effects of sampling and quantization, discrete systems analysis, sampled-data systems, and Z-domain and state space design. Prerequisite(s): ECE 684 or ME 659.

ECE 790. Independent Study in ECE (1-3).
Arranged individual, independent study in specialized content areas in electrical engineering under the supervision of a faculty member. Repeatable for credit. Prerequisite(s): departmental consent.

ECE 792. Linear Systems (3).
Reviews mathematics relevant to state-space concepts. Formulation of state-variable models for continuous-time and discrete-time linear systems. Concepts of controllability, observability, stabilizability and detectability. Pole placement and observer design. State transformation techniques and their use in analysis and design of linear control systems. Prerequisite(s): ECE 684 or ME 659.

ECE 794. Parallel Computing (3).
Introduces techniques with theory and syntax to program high performance computer systems for data analyses. Particular attention is given to the following areas: multicore/many-core architectures and multithreaded programming using application programming interfaces such as OpenMP, MPI and CUDA. Programming assignments and team projects give hands-on experience. Prerequisite(s): ECE 694 or instructor's consent.

ECE 795. Power System Protection (3).
Talks about the study of power system faults and application of relays for power system protection. Topics include symmetrical components as applied fault currents, current methods and skills to analyze power system under fault conditions, and the knowledge of current technologies of the power system protection for major components. Prerequisite(s): ECE 598.

ECE 796. Electric Power Distribution (3).
Analysis, design, modeling and simulation of radial medium-voltage electric power distribution systems. Simulations include power flow and short circuit. Prerequisite(s): ECE 598.