ELECTRICAL ENGINEERING (EE)

EE-210 Circuits I 3 Credits
Corequisites: EE-211
Prerequisites: PHYS-224 and PHYS-225 and (MATH-102 or MATH-102H or MATH-102X)
Fundamental DC and AC circuit analysis techniques are covered in this introductory course. Topics include circuit variables and elements; resistors, inductors, and capacitors; and sinusoidal steady-state analysis with power calculations.
Lecture: 3, Lab 0, Other 0

EE-211 Circuits I Lab 1 Credits
Corequisites: EE-210
Prerequisites: None
An introductory laboratory course designed to reinforce the fundamental analysis techniques discussed in EE-210, Circuits I. Topics include: safe use of laboratory equipment and experimental verification of analysis techniques.
Lecture: 0, Lab 2, Other 0

EE-212 Applied Electrical Circuits 3 Credits
Corequisites: MATH-204, MECH-231L
Prerequisites: PHYS-224 and PHYS-225
Application of electrical circuit components are covered in this course. Topics include: Ohm's law and Kirchhoff's laws; series and parallel circuits; voltage and current division rules; node-voltage and mesh-current methods; superposition; Thevenin's, and Norton's theorems; first- and second-order R-L-C circuits; steady-state analysis and power calculations for sinusoidally-varying (ac) sources; operational amplifiers; and diodes. This course will not satisfy the requirements of an Electrical or Computer Engineering degree.
Lecture: 3, Lab 0, Other 1

EE-240 Electromagnetic Fields and Applications 4 Credits
Prerequisites: PHYS-224 and PHYS-225
Basics of electromagnetic fields and applications are studied. Topics include: vector analysis; gradient, divergence, and curl; electrostatic fields; electrostatic boundary-value problems; magnetostatic fields; magnetic circuits; and Maxwell's equations for time-varying fields.
Lecture: 4, Lab 0, Other 0

EE-310 Circuits II 4 Credits
Prerequisites: EE-210 and (MATH-204 or MATH-204H)
A second course in circuit analysis. Topics include: first-order and second-order transient circuit analysis, the Fourier series, three-phase circuits, resonance, filters, Bode plots and magnetically coupled circuits.
Lecture: 4, Lab 0, Other 0

EE-312 PCB Design & Testing 4 Credits
Prerequisites: ECE-101 and EE-320 and EE-321
Minimum Class Standing: Junior
This is a hands-on ECE class with focus on the design process for building printed circuit boards (PCBs). Students will select a design project from among a list of options, based on interest. The Altium Designer software will be studied and used to develop circuit schematics, a PCB layout, a Bill-of-Materials, and other fabrication files. The PCBs will be designed to interface with an Arduino Uno microcontroller board, serving as an "Arduino shield". Upon receiving materials, students will build, test & verify their hardware. Students will then develop software for the Atmel ATmega328 microcontroller to operate their circuit and interact with it using a USB-Serial interface. The course will conclude with project demonstrations and a poster presentation open to all ECE students.
Lecture: 2, Lab 2, Other 0

EE-320 Electronics I 3 Credits
Corequisites: EE-321
Prerequisites: EE-210 and EE-211
The basic building blocks used in electronic engineering are studied. Topics include: operational amplifiers; diodes; MOS and bipolar devices; basic transistor amplifier configurations; and MOSFET digital logic circuits.
Lecture: 3, Lab 0, Other 0

EE-321 Electronics I Laboratory 1 Credits
Corequisites: EE-320
Prerequisites: EE-210 and EE-211
An introductory laboratory course designed to reinforce the topics in EE-320, Electronics I. Experiments include: PSPICE simulation, operational amplifiers; diodes; MOS and bipolar transistor configurations; MOSFET digital circuits.
Lecture: 0, Lab 2, Other 0

EE-325 Principles of Microelectronics Processing 4 Credits
Prerequisites: EE-320 and EE-321
The principles of semiconductor processing for modern integrated circuits are covered in this introductory course. Topics include a brief review of semiconductor devices and semiconductor circuit families, modern CMOS technology and process flow, crystal growth, semiconductor processing, thin film deposition oxidation, etching, lithography and an introduction to clean room principles. Principles of manufacturing process control and modeling for manufacturability will be presented. Computed simulation will be extensively used where appropriate.
Lecture: 4, Lab 0, Other 0

EE-336 Continuous-Time Signals and Systems 4 Credits
Prerequisites: (MATH-204 or MATH-204H) and EE-210
Minimum Class Standing: Sophomore
Introductory continuous-time signals and systems are studied. Topics include: definitions and properties of signals and systems, convolution, differential equations, Laplace transform with applications, Fourier series, and Fourier transform of continuous-time signals with applications.
Lecture: 4, Lab 0, Other 0

EE-338 Discrete-Time Signals and Systems 4 Credits
Prerequisites: (MATH-204 or MATH-204H) and EE-210
Minimum Class Standing: Sophomore
Introductory discrete-time signals and systems are studied. Topics include: definitions and properties of signals and systems, sampling, convolution, difference equations, Z transform with applications, and the Fourier transform of discrete-time signals with applications.
Lecture: 4, Lab 0, Other 0

EE-340 Electromagnetic Wave Propagation 4 Credits
Prerequisites: EE-240
Advanced concepts of electromagnetic fields are studied. Topics include: propagation of uniform plane waves in various material media; transmission line analysis; electromagnetic wave propagation in waveguides; and antennas.
Lecture: 4, Lab 0, Other 0

EE-342 Electrical Machines 4 Credits
Corequisites: EE-310
Prerequisites: EE-210 and EE-211 and EE-240
Operating principles and design concepts of various types of electrical machines are studied. Topics include: magnetic circuits, single-phase and three-phase transformers; dc motors and generators; three-phase alternators; synchronous motors, induction motors and single-phase motors.
Lecture: 3, Lab 2, Other 0

EE-346 High Voltage Generation and Measurement Techniques 4 Credits
Prerequisites: EE-210 and EE-211 and EE-240
Insulation overvoltage-tests are studied. Topics include: generation of high, direct, alternating, and impulse voltages; voltage multiplier circuits; resonant test circuits; resistive, capacitive and mixed high-voltage dividers; sphere gaps; electrostatic voltmeters, Kerr Cell; and electrostatic coupling, interference, and grounding and safety.
Lecture: 3, Lab 2, Other 0

EE-348 Electromagnetic Compatibility 4 Credits
Prerequisites: EE-210 and EE-240
Issues involved in designing electrical and electronic systems to achieve electromagnetic compatibility are studied. Topics include: interference sources; government regulations limiting conducted and radiated omissions; electric and magnetic field noise coupling; grounding; filtering; shielding; electrostatic discharge; spectral analysis of electromagnetic interference; design methods for minimizing radiated emissions from digital circuits; and measurements of system emissions and susceptibility.
Lecture: 4, Lab 0, Other 0

EE-399 EE Independent Study 4 Credits
Prerequisites: None
Lecture: 0, Lab 0, Other 0

EE-410 eMobility System Analysis & Control 4 Credits
Prerequisites: ECE-101 and (EE-210 and EE-211)
Minimum Class Standing: Junior
This course will provide system analysis and design methods for electrified road vehicles. Firstly, the components and subsystems of electrified powertrain will be reviewed with real application design, including battery, electric motor and inverter etc. Modeling and simulation methods with MATLAB/Simulink will be covered for students to adopt multi-physical level model skills. With the knowledge of the systems, powertrain design basics will be reviewed, including hybrid/electric powertrain configurations, E/E architecture and energy management strategies. Finally, functional safety topics will be covered, including subjects and work products of road vehicle functional safety standard ISO-26262. System and function analysis methods, such as fault tree analysis (FTA), will be covered as well.
Lecture: 4, Lab 0, Other 0

EE-420 Electronics II 4 Credits
Prerequisites: EE-310 and EE-320 and EE-321
Advanced concepts of electronic engineering are studied. Topics include: nonlinear circuits; active filters; differential and multistage amplifiers; pulse and switching circuits; integrated circuits; and electronic system design.
Lecture: 3, Lab 2, Other 0

EE-421 Energy Storage Systems with EV Applications 4 Credits
Prerequisites: (EE-210 and EE-211) or EE-212
This course introduces the basics of energy storage systems. Several competing energy storage concepts and management systems will be considered with emphasis on rechargeable Li-ion batteries for EV applications. The course will focus on the fundamentals of Li-ion batteries with respect to the physical principles of operation, design, modeling and state estimation, as well as battery management systems.
Lecture: 4, Lab 0, Other 0

EE-424 Power Electronics and Applications 4 Credits
Prerequisites: EE-310 and EE-320 and EE-321
Electrical energy conversion principles, along with several powerelectronic devices and converter topologies are studied. Topics include: characteristics of diodes, thyristors, BJTs, IGBTs, and MOSFETs; transistor gatedrive circuits; operating principles of AC/DC, DC/DC and DC/AC converter circuits; isolation and isolated DC/DC converter circuits; power loss and efficiency calculations; high-frequency magnetic component design, and computer-aided analysis of the dynamic response of the converter circuits. Applications involving the dynamic representation and speed control of electric motors, together with power electronics, are also studied.
Lecture: 3, Lab 2, Other 0

EE-427 Semiconductor Device Fundamentals 4 Credits
Prerequisites: EE-320
Basic semiconductor theory for solid-state devices, diode theory, and applications of theory for transistors are studied. Topics include: energy bands, carrier statistics, equilibrium carrier concentrations, carrier transport, electrostatic devices, diode I-V characteristics, optical device applications, microwave device effects, and BJT, JFET, MESFET and MOSFET transistor models.
Lecture: 4, Lab 0, Other 0

EE-430 Communication Systems 4 Credits
Prerequisites: EE-310 and EE-320 and MATH-258 and (EE-336 or EE-338)
The study of methods used in electronic communication systems. Topics include: Fourier Transforms; analysis of distortion over a communication channel; autocorrelation of deterministic and random signals; energy and power spectral density; amplitude modulation; frequency modulation; phase modulation; digital line coding and modulation; communication circuitry.
Lecture: 4, Lab 0, Other 0

EE-432 Feedback Control Systems 4 Credits
Prerequisites: EE-310 or EE-336
Time and frequency domain representations of control systems are studied. Topics include: stability criteria; root locus methods; frequency response techniques, s-plane design methods. Design and evaluation of control systems are supplemented with computer aided control system design software.
Lecture: 3, Lab 2, Other 0

EE-433 Digital Control Systems 4 Credits
Prerequisites: EE-338 and EE-432
Minimum Class Standing: Senior 1
Control of continuous-time processes using computer-based controllers is studied. Topics include design of control algorithms for implementation, modeling of discrete time systems, application of z-transforms, stability analysis, root locus analysis, controller design via conventional techniques, state-space analysis and modeling, and design and implementation of digital controller. Implementation of real-time digital controllers is performed in the laboratory.
Lecture: 3, Lab 2, Other 0

EE-434 Digital Signal Processing 4 Credits
Prerequisites: ECE-101 and EE-338
Basic principles, design and applications of digital signal processing systems are presented. Topics include: review of discrete-time signals and systems, the z-transform, discrete-time Fourier analysis, the Discrete Fourier Transform, the Fast Fourier Transform, digital filter structures, FIR filters, and IIR filters. This course includes extensive use of MATLAB and experimental design projects using real-time signal processors.
Lecture: 3, Lab 2, Other 0

EE-443 Fundamentals of Power Systems 4 Credits
Prerequisites: EE-210 and EE-211
Basic structure of electrical power systems and characteristics of power transmission lines, transformers and generators are studied. Topics include: conventional and renewable energy resources for power generation, representation of power systems; symmetrical three-phase fault analysis; symmetrical components; unsymmetrical fault computations; and simulation tools and network analyzers.
Lecture: 3, Lab 2, Other 0

EE-444 Computational Methods in Power Systems 4 Credits
Prerequisites: EE-344
Matrix analysis of power system networks is studied. Topics include: power flow study of large scale interconnected power systems using Gauss-Seidel and Newton-Raphson methods; computer-aided short circuit analysis of large systems; economic operation of power networks; transient stability analysis; overvoltage calculations; and fundamentals of power system protection.
Lecture: 4, Lab 0, Other 0

EE-446 Vector Control of AC Electric Machines 4 Credits
Prerequisites: EE-240 and EE-310 and EE-320 and EE-321
Methods of controlling electric machines and their applications in electric vehicles are discussed. Topics include the theory of permanent-magnet and induction machines; coordinate-frame transformations; analysis and tuning of torque and speed control systems; modeling and dynamics of electric drives and vehicles, power-electronic devices, power-electronic circuits and switching schemes; rotor-flux oriented vector control; regenerative braking; and rotor-flux position-sensing methods. Machine and vehicle models will be developed using MATLAB Simulink. A low-voltage permanent-magnet machine and power-electronic inverter will be analyzed and tested.
Lecture: 3, Lab 2, Other 0

EE-482 Robot Dynamics and Control 4 Credits
Corequisites: EE-432
Prerequisites: None
Review of mathematical principle for robotics including matrix operations and their concepts. Principles of robot analysis, design, and operation are presented. Topics include review of historical robotics evolutions and applications, robot coordinate system placement rules, kinematic model development, kinematic solutions and analysis, trajectory planning and movement optimization, collision avoidance and path planning, feedback control system for robotics, feedforward, study of sensors for robotics applications, vision system types and application for robotics and mobile robots.
Lecture: 4, Lab 0, Other 0

EE-490 Senior Electrical Engineering Design Project 4 Credits
Prerequisites: CE-320 and EE-240 and EE-310 and EE-320 and EE-321 and (EE-336 or EE-338)
Minimum Class Standing: Senior
Students are prepared for engineering practice through a major design experience based on knowledge and skills acquired in earlier course work. They work in teams to creatively solve an open-ended engineering design problem and develop a prototype system to meet a given specification. The design will emphasize electrical engineering, but will be multidisciplinary. The specification requires the design solution to incorporate appropriate engineering standards with consideration of multiple constraints such as: public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Designs are documented in a professional manner and presented publicly for a range of audiences.
Lecture: 2, Lab 4, Other 0