UNDERGRADUATE COURSES

- **EEE 3300. Electronics (3)**. Prerequisite for Electrical **and** Computer Engineering Majors: EEL 3002L (C- or better); Corequisite for Electrical **and** Computer Engineering Majors MAP 2302 (C- or better). Additional Prerequisite for **only** Electrical Engineering Majors: EEL 3111 (C- or better). Additional Prerequisite for **only** Computer Engineering Majors: EEL 3003. This course covers diode models and circuits, DC biasing of bipolar-junction and field-effect transistors, small- and large-signal transistor models, and frequency analysis of single-stage AC amplifiers.

- **EEE 3300L. Electronics Laboratory (1)**. Prerequisites: EEL 3112 (C- or better) and EEL 3112L (C- or better); Corequisites: EEE 3300 (C- or better). Corequisite: EEE 3300. This laboratory supports EEE 3300, Electronics.

- **EEE 4288. Biomimetic Sensors and Signal Processing (3)**. Prerequisite: EEL 3135. In this course, biomimetic implies the mimicry of biology. This course covers biologically-inspired structure and function concepts used for novel sensor designs and signal processing. Cursory descriptions of biological phenomena are followed by electronic sensor designs and natural signal processing algorithms. This course focuses on natural sensory systems and innovative engineering applications inspired by them.

- **EEE 4301. Electronic Circuits and Systems Design (3)**. Prerequisites: EEE 3300 and EEE 3300L.
  Corequisite: EEE 4301L. This course uses computer-aided design programs and covers multistage amplifier analysis and design. The course focuses on feedback and operational amplifiers, A-to-D and D-to-A converters, and waveshaping and waveforming generators, including oscillators, voltage regulators, and power circuits.

- **EEE 4301L. Electronic Circuits and Systems Laboratory (1)**. Prerequisites: EEE 3300 and EEE 3300L.
  Corequisite: EEE 4301. This course is an advanced electronic laboratory.

- **EEE 4313. CMOS Digital IC Design (3)**. Prerequisite for Electrical Engineering Majors: EEE 3300; Prerequisite for Computer Engineering Majors: EEL 3003. This is an elective course that introduces students to the design of CMOS digital IC circuits using IC layout techniques.

- **EEE 4330. Microelectronics Engineering (3)**. Prerequisites: EEE 3300 and EEE 3300L. This course covers design and fabrication of solid-state devices. Topics include oxidation, diffusion, metallization, photolithography, and device characterization.

- **EEE 4351. Solid-State Electronic Devices (3)**. Prerequisites: EEE 3300 and EEE 3300L. This course covers solid-state physics as applied to electronic devices. The course focuses on semiconductor materials, conduction process in solids, device fabrication, diffusion processes, and negative conduction devices.

- **EEE 4376C. Introduction to Analog IC Design (3)**. Prerequisite: EEE 4301. This course covers the design and analysis of bipolar and MOS analog integrated circuits. The course focuses on operational amplifier design, analog multipliers, active loads, current sources, and active filters.

- **EEE 4377. Mixed Signal ICs (3)**. Prerequisite: EEL 4313 or EEL 4376C. This course introduces mixed-signal processing using analog and digital integrated circuits. The course focuses on fundamentals of sampled data systems, nonlinear and dynamic analog circuits, Nyquist-rate data converters, over-sampling data converters and digital filters, as well as the use of computer-aided design programs.

- **EEE 4450. Modeling and Simulation of Semiconductor Devices (3)**. Prerequisite: EEE 3300. This course covers various numerical techniques for the modeling and simulation of semiconductor devices, such as pn-junctions, metal-oxide semiconductor contacts, metal-oxide-semiconductor field effect transistors, and bipolar devices. Special emphasis is on the description and simulation of electron and hole transport in semiconductor devices.

- **EEE 4510. Digital Signal Processing (3)**. Prerequisite: EEL 3135. This course covers topics such as sinusoids, periodic signals, and Fourier spectra. Sampling of continuous-time signals, aliasing. Impulse response of linear, discrete-time systems, convolution. FIR filters and implementation. Frequency response of FIR filters. Z-transforms. IIR filters, poles and zeros, frequency response. Realization of IIR filters. Discrete Fourier transform and the FFT algorithm. MATLAB exercises are assigned.

- **EEE 4550. Radar (3)**. Prerequisites: EEL 3473 and EEL 3135. Corequisite: EEL 4021. This course examines basic concepts of radar systems including radar range equation, radar cross-section calculations, random processes and noise, array antennas, beamsteering, doppler and range processing, FM and CW systems, pulse compression, synthetic aperture radar, and clutter.

- **EEE 4773. Machine Learning (3)**. Prerequisites: EEL 3135, MAS 3105, knowledge of Matlab and/or Python, and instructor permission. This course is designed for senior undergraduate students from engineering disciplines and introduces students to the theory and engineering applications of machine learning including neural networks, fuzzy logic, genetic algorithms, supervised and unsupervised learning algorithms. This course places emphasis on engineering applications in controls, power systems, and robotics.

- **EEE 4872. Artificial Intelligence (3).** Prerequisites: COP 4530 and EEL 4021. This course instructs students in basic artificial intelligence (AI) techniques of search, machine learning, natural language processing, robotics, and image processing. In this course, potential/current limitations are analyzed; as are human interaction in a decision-making environment.

- **EEL 3002L. ECE Engineering Tools Lab (2)**. Corequisite: EEL 3111 (C- or better). This is an introductory laboratory for students entering the electrical and computer engineering programs. The basic topics include: lab safety issues; solving engineering problems using software tools such as MATLAB and Mathematica; electric circuit simulations using c software packages such as Multisim and OrCAD; electric circuit design and instrumentation; the proper use of test and measurement equipment.

- **EEL 3003. Introduction to Electrical Engineering (3)**. Prerequisites: MAC 2312 (C- or better) and PHY 2049C (C- or better). This course is an introduction to electrical engineering concepts for non-electrical engineering majors. The course focuses on circuit theory for interfacing sensors and actuators. Operational Amplifiers are included. Not accepted for credit toward BSEE and BSCpE.

- **EEL 3003L. Introduction to Electrical Engineering Laboratory (1)**. Prerequisites: MAC 2312 and PHY 2049C. Corequisite: EEL 3003. This laboratory supports EEL 3003. Must be taken concurrently with first enrollment in EEL 3003. Must be dropped if EEL 3003 is dropped.

- **EEL 3111.Circuit Analysis I (3)**. Prerequisite: MAC 2312 (C- or better). Corequisite: PHY 2049C (C- or better). This course explores topics such as current, voltage, and power; resistors, inductors, and capacitors; network theorems and laws; operational amplifiers, phasors; impedances; sinusoidal steady-state analysis.

- **EEL 3112. Circuit Analysis II (3)**. Prerequisites: EEL 3111 (C- or better) and EEL 3002L (C- or better). Corequisite: MAP 2302 (C- or better). This course examines sinusoidal steady-state power analysis; three-phase circuits; operational amplifier; transient and forced response; frequency response; two-port networks; and circuit analysis.

- **EEL 3112L. Advanced Circuits with Computers Laboratory (1)**. Prerequisites: EEL 3111, EEL 4905 (Taken as ECE Engineering Tools Lab). Corequisite: EEL 3112. This lab includes instrumentation and measuring techniques; current, voltage, and power measurements; response of passive circuits; AC and DC design; computer application.

- **EEL 3135. Signal and Linear System Analysis (3)**. Prerequisites: MAP 2302 and MAS 3105 (C- or better) required for *both* Electrical Engineering and Computer Engineering Majors. The corequisite *only* for CpE students is EEL 3003 (C- or better). The corequisite for *only* EE students is EEL 3112 (C- or better). This course focuses on the classification and representation of signals and systems; Laplace transform; Z-transform; convolution; state variable techniques; stability and feedback.

- **EEL 3216. Fundamentals of Power Systems (3)**. Prerequisite: EEL 3112. This course is an introduction to the fundamentals of energy conversion; structure of power systems; and power system components: transformers, rotating machines, and transmission lines. The operation and analysis of power systems are presented.

- **EEL 3472. Electromagnetic Fields I (3)**. Prerequisites: EEL 3112, MAP 2302 or MAP 3305, MAS 3105 or MAP 3306, and PHY 2049C. This course explores electrostatic field—Gauss's law; boundary conditions; capacitance; Laplace's and Poisson's equations; energy, forces, and torques. The steady electric current. The magnetostatic field-vector potential; Ampere's and Biot-Stavart laws; inductance; energy, forces, and torques. Quasistatic fields; electromagnetic induction.

- **EEL 3473. Electromagnetic Fields II (3)**. Prerequisite: EEL 3472. This course examines topics such as Maxwell's equations, plane electromagnetic waves, group velocity, polarization, Poynting vector, boundary conditions, reflection and refraction of plane waves, skin effect, transmission line analysis, impedance matching, wave guides and cavity resonators, fundamentals of radiation and antennas.

- **EEL 3705. Digital Logic Design (3)**. Corequisites: COP 3014 and EEL 3705L. This course covers fundamental topics in digital logic design, including the use of a hardware description language, as well as number systems Boolean algebra, logic simplification, combinational, and sequential logic circuits.

- **EEL 3705L. Digital Logic Laboratory (1)**. Corequisite: EEL 3705. This laboratory supports EEL 3705. This course introduces Electrical and Computer Engineering majors to various practical aspects of Digital Logic. This includes analysis, design and testing of digital logic circuits. Design and implementation are covered using Altera devices.

- **EEL 3927. Engineering Design Concepts (3)**. Prerequisites for EE students: ENC 1101 and ENC 2135. Corequisite for EE students: EEL 3112. Prerequisites for CpE students: ENC 1101, ENC 2135, and EEL 4746. This course introduces the skills and knowledge necessary to effectively complete a capstone project. Students are presented with concepts in design, systems engineering, project management, engineering team organization, ethics, and professionalism.

- **EEL 4005. Measurements and Instrumentation for Electrical Engineers (3).** Prerequisite: EEL 3112. This course introduces various measurement methods and instrumentation techniques used in electrical engineering practice and research.

- **EEL 4021. Statistical Topics in Electrical Engineering (3)**. Prerequisites: MAS 3105 and (EEL3112 or EEL3003). This course examines the use of probability and statistical concepts in electrical engineering applications. Elementary probability—sets, sample spaces, axioms, joint and conditional probability. Random variables—distribution and density functions. Operations in random variables—expectation, moments, transformation of random variables. Introduction to random processes. Multiple random variables. Elements of statistics: parameter estimation and hypothesis testing.

- **EEL 4070. Introduction to Energy Storage (3)**. Prerequisite: EEL 3003 or EEL 3111. This course introduces students to energy storage technologies and devices with major focus on electrochemical storages including advanced rechargeable batteries, electrochemical capacitors, and fuel cells.

- **EEL 4113. Advanced Linear Networks (3)**. Prerequisite: EEL 3135. This course explores topics such as synthesis of LC one-port networks, synthesis of LC two-port networks; operational amplifier applications; active filters; approximation methods; switched-capacitor filters.

- **EEL 4213. Power Systems I (3)**. Prerequisite: EEL 3216. This course focuses on the analysis of electric power systems using system modeling for large-scale power networks; admittance and impedance matrix formation; power flow; optimal dispatch; symmetrical components; balanced and unbalanced fault analysis; and transient stability studies.

- **EEL 4217L. Power and Energy Lab (1)**. Prerequisite: EEL 3216. This course is intended to give the student practical experience with motors, generators, transformers and power system instrumentation equipment. Students learn the principles of electromechanical energy conversion by connecting, operating, and controlling induction, synchronous, and dc machines. Transport of electrical energy through transmission lines is also explored.

- **EEL 4220. Electromechanical Dynamics (3)**. Prerequisites: EEL 3216 and EEL 3472. This course focuses on the study of magnetic circuits, electromagnetic torques, and induced voltages. Topics covered include induction motors, variable speed drives, Park's transforms, synchronous machines and generator controls, DC machines, controls, and drives.

- **EEL 4231. Converter Modeling and Control (3)**. Prerequisite: EEL 4243. This course provides a study of DC-AC and DC-DC converter-modeling techniques and control schemes. Topics include average switch models, voltage-source and current-source converter models, current programmed control, and active filter control.

- **EEL 4243. Power Electronics (3)**. Prerequisites: EEE 3300 and EEL 3135. This course is designed to develop a basic understanding of using switched electronic circuits for the conversion and regulation of power. The course focuses on the basic converters and their steady state analysis. Dynamic modeling analysis, controller design, power semiconductor device, and simulation also are covered.

- **EEL 4244. Power Conversion and Control (3)**. Prerequisites: EEE 3300 and EEL 3112. This course introduces solid-state power conversion and control circuits, including analysis and design of nonlinear multiple-phase circuits with sinusoidal and non-sinusoidal variables; constant-frequency and variable-frequency input conversions; variable-frequency inverters; sensing and processing circuits supporting control systems; and embedded microprocessor control systems.

- **EEL 4280. Renewable Energy Generation I (3)**. This course is an introduction to renewable energy generation. Topics covered include smart grid system, hybrid electric vehicle, and grid-connected PV inverters. Emphasis is placed on the energy conversion techniques applied in the renewable energy source and energy storage elements.

- **EEL 4281. Photovoltaics (3)**. Prerequisites: EEE 3000. This course educates students in the design and applications of solar energy technology. This course focuses on theoretical fundamentals of solar energy conversion, types of solar cells and their operations, optical engineering, and energy storage and distribution systems. The course covers solar energy needs, current trends in photovoltaic energy engineering, solar cell material science, design and installation of solar panels for residential and industrial applications and connections to the national grid and cost analysis of the overall system.

- **EEL 4282. Renewable Energy Generation II (3)**. This course is an introduction to renewable energy generation. Topics covered include smart grid system, hybrid electric vehicle, and grid-connected PV inverters. Emphasis is placed on the energy conversion techniques applied in the renewable energy storage elements.

- **EEL 4347. Introduction to Cybersecurity (3)**. Prerequisites: COP 3014 and EE: 3705. This course is an introduction to computer security: symmetric ciphers, public-key cryptosystems, digital signatures, hashes, message authentication codes, key management and distribution, authentication protocols, vulnerabilities and malware, access control, and network security.

- **EEL 4435L. Electromagnetics Laboratory (1)**. Prerequisite: EEL 3473. This course focuses on the applications of electromagnetic field theory. Experiments include field mapping, transmission lines, spectrum analysis, impedance matching, waveguides, antennas, radar, and fiber optics.

- **EEL 4452. Optical Sensors (3)**. Prerequisite: EEL 3473. This course examines the basic concepts of optical sensors and essential optics. Topics include intensity, phase, and frequency modulated optical fiber sensors and their applications, distributive sensing systems, and optical fibers in signal processing.

- **EEL 4461. Antenna Systems (3)**. Prerequisite: EEL 3473. This course covers topics such as antenna theory, including Hertzian dipoles, thin linear antennas, aperture antennas, arrays, loop antenna, slots, horns, and waveguides.

- **EEL 4515. Digital Communication Systems (3)**. Prerequisite: EEL 3135 (C- or better). Corequisite: EEL 4021 (C- or better). This course covers topics such as sampling principle, spectral analysis of digital waveforms and noise, pulse and digital transmission systems, digital multiplexing, error probabilities, and system performance.

- **EEL 4595. Wireless Communications and Networking (3)**. Prerequisites: COP 3014 or equivalent, EEL 3135, and EEL 4021. This course covers the fundamentals of wireless communications and systems. The core topics include radio-wave propagation characteristics of wireless channels; modulation and demodulation techniques for mobile radio; reception techniques for wireless systems; fundamentals of cellular communications; multiple access techniques; wireless networking; and hybrid networking of a wireless system and the Internet.

- **EEL 4652. Analysis and Design of Control Systems (3)**. Prerequisite: EEL 3135. This course focuses on continuous system modeling; stability of linear systems; frequency response methods; the root locus method; state-space methods.

- **EEL 4710. Introduction to Very High Speed Integrated Circuit Hardware Description Language (3)**. Prerequisites: EEL 3705 and EEL 3705L. This course offers an introduction to the VHDL hardware description language: data type, operations, combinational, sequential, components, functions, and procedures using VHDL. The course provides an overview of FPL devices and design tools.

- **EEL 4710L. Introduction to VHDL Laboratory (1)**. Prerequisites: EEL 3705 and EEL 3705L. Corequisites: EEL 4710. This course supports EEL 4710. The course introduces Electrical and Computer Engineering majors to various practical aspects of circuit design using Very High-Speed Integrated Circuits Hardware Description Language (VHDL).

- **EEL 4713. Computer Architecture (3)**. Prerequisites: COP 3014 and EEL 4746. This course presents modern computer architectures by studying how the relationships between hardware and software impact performance, machine language definition, processor data path and control designs, interfacing, and advanced topics.

- **EEL 4727. Digital Signal Processing with Field Programmable Gate Arrays (3)**. Prerequisite: EEL 4710. This course is a review of Field Programmable Gate Arrays (FPGAs), HDL, mathematics, signals and systems. Computer arithmetic concepts, DSP system design of FIR filters, IIR filters, DFT, FFT, and wavelets filter banks are also covered.

- **EEL 4735. Advanced Digital Hardware (3)**. Corequisite: EEL 4710. This course covers number representations, addition/subtraction, multiplication, division, real arithmetic, hardware algorithms for function evaluation, and implementation issues.

- **EEL 4742. Advanced Microprocessor-Based System Design (3)**. Prerequisites: EEL 4746 and EEL 4746L. Corequisite: EEL 4742L. This course covers advanced concepts in microprocessor-based system design. Topics include microprocessor architectures, hardware/software synchronization, interrupts, interface protocols, power management, and introduction to real-time operating systems.

- **EEL 4742L. Advanced Microprocessor-Based System Design Laboratory (1)**. Prerequisites: EEL 4746 and EEL 4746L. Corequisite: EEL 4742. This course is a laboratory in support of EEL 4742 Advanced Microprocessor-Based System Design.

- **EEL 4746. Microprocessor-Based System Design (3)**. Prerequisites: COP 3014 (C- or better), EEL 3705 (C- or better), and EEL 3705L (C- or better). Corequisite: EEL 4746L (C- or better). This course explores fundamental concepts in microprocessor-based system design. Topics include: C and assembly level programming, computer architecture and organization, hardware timers, interrupt controllers, and device interfacing utilizing parallel and serial I/O.

- **EEL 4746L. Microprocessor-Based System Design Laboratory (1)**. Prerequisites: EEL 3705 (C- or better) and EEL 3705L (C- or better). Corequisite: EEL 4746 (C- or better). Laboratory course in support of EEL 4746.

- **EEL 4759. Digital Image Processing (3)**. Prerequisite: MAP 2302. This course is an introduction to image processing techniques, including theoretical development, analysis, and practical implementation. A project that includes implementation grounds the successful student in current engineering practice.

- **EEL 4781. Computer Networks (3)**. Prerequisite: COP 3330. This course covers the fundamentals of computer network design and analysis; network architecture using layered approach; analysis and examples of network protocols and standards; techniques for evaluating network performance selecting network protocols.

- **EEL 4873. Embedded Microprocessor System Design (3)**. Prerequisite: EEL 3705. This course teaches students to be able to design, configure, and implement a complete embedded microprocessor system using soft-core, parameterized, or hard core microprocessors for FPGAs including required peripherals and software tools.

- **EEL 4887. CpE Languages: Introduction to Python, Verilog, and MatLab/Simulink (3)**. Prerequisite: EEL 4710. Corequisite: COP 3330. In this course, computer programming is used to improve quantitative problem-solving skills. This is a comprehensive course using the PYTHON, VERILOG, and MATLAB/SIMULINK programming languages.

- **EEL 4905r. Directed Individual Study (1–3)**. Prerequisites: Junior standing and "B" average in electrical engineering courses. Normally may be repeated to a maximum of six semester hours. Requires department approval.

- **EEL 4906r. Honors Work in Electrical Engineering (1–6)**. Prerequisite: Admission to the honors program. This course consists of independent or directed research in a specialized area beyond the current curriculum in electrical engineering. May be repeated to a maximum of nine (9) credit hours; repeatable within the same term.

- **EEL 4911C. Senior Design Project I (3)**. Prerequisite: Prerequisites for all ECE students: EEL 3927 and EEL 3135. Corequisites for only EE students: EEE 3300 and EEL 4746. Corequisite for only CpE students: EEL 4742. This course exposes senior students to concepts in design, project management, engineering team organization, and professionalism. Students are grouped into design teams where these principles are put into practice in organizing, proposing, and developing an engineering project. Periodic written reports and oral presentations and a final written proposal are required. The lecture material and texts provide instructions on project management, ethics, and design skills.

- **EEL 4914C. Computer Engineering Senior Design Project II (3)**. Prerequisite: EEL 4911C. This course exposes senior students to the concepts in design, project management, engineering team organization, ethics, design skills, and professionalism. Students are grouped into design teams where these principles are put into practice in organizing, proposing, and developing an engineering project. Periodic written reports and oral presentations, and a final written report are required.

- **EEL 4915C. Electrical Engineering Senior Design Project II (3)**. Prerequisite: EEL 4911C. This course exposes senior students to the concepts in design, project management, engineering team organization, ethics, design skills, and professionalism. Students are grouped into design teams where these principles are put into practice in organizing, proposing, and developing an engineering project. Periodic written reports and oral presentations, and a final written report are required.

- **EEL 4930r. Special Topics in Electrical Engineering (3)**. This course covers special topics in electrical engineering with emphasis on recent developments. Topics vary; consult the instructor. May be repeated to a maximum of twelve (12) credit hours.