

# ELECTRICAL AND ELECTRONIC ENGINEERING (EEE)

<p><b>EEE 64. Introduction to Logic Design.</b> <b>4 Units</b>  <b>Prerequisite(s):</b> CSC 15 or CSC 25            Covers the following topics: logic gates, binary number system, conversion between number systems, Boolean algebra, Karnaugh maps, combinational logic, digital logic design, flip-flops, programmable logic devices (PLDs), counters, registers, memories, state machines, designing combinational logic and state machines into PLDs, and basic computer architecture. Lab emphasizes the use of software equation entry design tools, the use of a schematic entry, and the use of a logic simulation design tool. Lab assignments are design-oriented.            Cross Listed: CPE 64; only one may be counted for credit.</p>	<p><b>EEE 109. Electronics II.</b> <b>4 Units</b>  <b>Prerequisite(s):</b> EEE 108, EEE 108L, EEE 117, EEE 117L; and )GWAR Certification before Fall 09, or WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).            Differential and multistage amplifiers, high frequency models (BJTs and FETs), feedback and sensitivity, power amplifiers, oscillators and waveform shaping circuits. Advanced use of PSPICE. Lecture three hours; laboratory three hours.</p>
<p><b>EEE 64W. Introduction to Logic Design Workshop.</b> <b>1 Unit</b>  <b>Corequisite(s):</b> EEE 64.            Assists students in developing a more thorough understanding of logic simulation and logic design. Focus is on problem solving and design. Activity two hours. Lecture three hours; laboratory three hours.            Cross Listed: CPE 64W; only one may be counted for credit.</p>	<p><b>EEE 110. Advanced Analog Integrated Circuits.</b> <b>3 Units</b>  <b>Prerequisite(s):</b> EEE 109 or consent of instructor.            The use of operational amplifiers in circuit designs for applications such as filtering, switched capacitor design, sample and hold design, instrumentation amplifiers, and voltage reference circuitry will be explored, as well as topics in Feedback Theory.</p>
<p>Credit/No Credit</p>	<p><b>EEE 111. Advanced Analog Integrated Circuits Laboratory.</b> <b>1 Unit</b>  <b>Prerequisite(s):</b> EEE 109; either EEE 110 or EEE 230. EEE 110 or EEE 230 may be taken concurrently.            Circuit design, mask design, and simulation of integrated circuitry. Use of CAD software to prepare design for fabrication. Individual and group design projects. Laboratory three hours.</p>
<p><b>EEE 102. Analog/Digital Electronics.</b> <b>3 Units</b>  <b>Prerequisite(s):</b> ENGR 17.  <b>Corequisite(s):</b> EEE 102L.            Introduction to analog/digital electronics, diodes, FET's, BJT's, DC biasing, VI characteristics, single-stage amplifiers, power supplies and voltage regulators, power electronic devices, OP-amps, active filters, A/D and D/A converters. PSPICE used extensively.  <b>Note:</b> Cannot be taken for credit by E&amp;EE Majors.</p>	<p><b>EEE 117. Network Analysis.</b> <b>3 Units</b>  <b>Prerequisite(s):</b> ENGR 17, MATH 45, and PHYS 11C  <b>Corequisite(s):</b> EEE 117L.            Review of sinusoidal steady state, phasors, complex power, three phase power, mutual inductance, series and parallel resonance. Introduction to application of Laplace transforms in network analysis, transfer functions, Bode plots, Fourier series, two-port circuits.</p>
<p><b>EEE 102L. Analog/Digital Electronics Laboratory.</b> <b>1 Unit</b>  <b>Prerequisite(s):</b> ENGR 17.  <b>Corequisite(s):</b> EEE 102.            Introduction to analog/digital electronics, diodes, FET's, BJT's, DC biasing, VI characteristics, single stage amplifiers, power supplies and voltage regulators, power electronic devices, OP-amps, active filters, A/D and D/A converters. PSPICE used extensively.  <b>Note:</b> Cannot be taken for credit by E&amp;EE Majors.</p>	<p><b>EEE 117L. Networks Analysis Laboratory.</b> <b>1 Unit</b>  <b>Corequisite(s):</b> EEE 117.            Introduces fundamental laboratory techniques while demonstrating the concepts introduced in the EEE 117 lecture. The computer simulation language PSPICE is introduced and applied. Laboratory three hours.</p>
<p><b>EEE 108. Electronics I.</b> <b>3 Units</b>  <b>Prerequisite(s):</b> EEE 117.  <b>Corequisite(s):</b> EEE 108L.            Introduction to electronics, ideal OP-AMPS, BJTs, FETs, DC biasing, VI characteristics, single stage amplifiers, low frequency small signal models, power supplies and voltage regulation. PSPICE required.</p>	<p><b>EEE 120. Electronic Instrumentation.</b> <b>4 Units</b>  <b>Prerequisite(s):</b> EEE 108, EEE 117; EEE 108 may be taken concurrently.            Fundamental principles of sensors and instrumentation systems, together with their electrical implementation, such as biasing and signal conditioning circuits. Temperature, force, pressure, and mechanical sensors. Optical sensors, including a brief introduction to light sources and detectors. Applications to biomedical engineering and industrial control. Lecture three hours; laboratory three hours.</p>
<p><b>EEE 108L. Electronics I Laboratory.</b> <b>1 Unit</b>  <b>Prerequisite(s):</b> EEE 117, EEE 117L.  <b>Corequisite(s):</b> EEE 108.            Characteristics and applications of OP-AMPS, rectifiers, BJTs and FETs. Introduction to GPIB, PSPICE and LabVIEW. Laboratory three hours.</p>	<p><b>EEE 122. Applied Digital Signal Processing.</b> <b>3 Units</b>  <b>Prerequisite(s):</b> EEE 117, EEE 180.  <b>Corequisite(s):</b> EEE 180            Application of digital signal processing to biomedical signals. Origin and characteristics of biomedical signals and contaminations. Preparation of biomedical signals for processing, including sensors, amplification, filtering, sampling, and quantization. Time-domain processing, including peak and zero-crossing detection, time interval measurement, peak height, and moving average estimates of mean and root mean square value. Frequency domain processing, including filtering to separate biomedical signal components and spectrum estimation. Joint time-frequency analysis.</p>
	<p><b>EEE 130. Electromechanical Conversion.</b> <b>3 Units</b>  <b>Prerequisite(s):</b> EEE 117 and EEE 161            Magnetic circuits and principles of electromechanical energy conversion, transformers, DC machines, asynchronous AC machines, synchronous AC machines, introduction to special machines.</p>

- EEE 131. Electromechanics Laboratory. 1 Unit**  
**Prerequisite(s):** EEE 117, EEE 130 (EEE 130 may be taken concurrently), and (GWAR Certification before Fall 09, or WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).  
 Direct current motor and generator characteristics, three phase synchronous motor and synchronous generator characteristics, single phase power transformer short circuit and no-load tests, frequency changer tests and tests on DC and AC machine models, potential and current transformers.
- EEE 135. Renewable Electrical Energy Sources and Grid Integration. 3 Units**  
**Prerequisite(s):** EEE 130.  
 The study of existing sources of renewable electric energy such as wind, solar, geothermal, hydro, tidal, wave power, and biomass. Emphasis on wind and solar energy sources and their integration into the electric power grid. Various energy storage methods to accommodate the intermittent nature of these resources. Economic constraints, environmental benefits and institutional regulations.
- EEE 136. Smart Electric Power Grid. 3 Units**  
**Corequisite(s):** EEE 142 or EEE 144.  
 Smart grid to enhance reliability, security, robustness and efficiency of transmission and distribution systems. Integration of renewable energy sources and distributed generation. Energy storage systems. Advanced metering infrastructure, home-area networks, micro-grids, real-time pricing, plug-in hybrid vehicles, demand response, load curve sharing. Control, monitoring and protection grid; SCADA systems. Voltage and load frequency control to ensure balance. Enabling active participation of consumer. Anticipating and responding to system disturbance in self healing manner. Providing power quality for digital systems needs.
- EEE 141. Power System Analysis I. 3 Units**  
**Prerequisite(s):** EEE 117 and EEE 161  
 Characteristics of power system components. Transmission line parameters and the steady state performance of transmission lines. Introduction to solutions of linear and nonlinear algebraic equations using Gauss, Gauss-Seidel, and Newton-Raphson techniques. Introduction to power flow analysis.
- EEE 142. Power System Analysis II. 3 Units**  
**Prerequisite(s):** EEE 130, EEE 141, and EEE 184  
 Review of the fundamentals in electric energy systems; power flow analysis, disturbance of normal operating conditions, symmetrical components and sequence impedances, analysis of balanced and unbalanced faults; a brief review of protection systems; optimum allocation and dispatching of generators; dynamic system control; introduction to stability studies. Students in the course will use MATLAB to solve problems.
- EEE 143. Power System Laboratory. 1 Unit**  
**Prerequisite(s):** EEE 130, EEE 141, and (GWAR Certification before Fall 09, or WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).  
 Simulation of three phase operations and transmission line operation including voltage regulation, efficiency of long lines, power system stability, voltage control and load-frequency control, load flow and optimal dispatch for simplified interconnected systems.
- EEE 144. Electric Power Distribution. 3 Units**  
**Prerequisite(s):** EEE 130.  
 Operation and design of utility and industrial distribution systems including distribution system planning; load characteristics; application of distribution transformers; design of subtransmission lines, distribution substations, primary systems, secondary systems; application of capacitors; voltage regulation and reliability.
- EEE 145. Power System Relay Protection and Laboratory. 4 Units**  
**Prerequisite(s):** EEE 141  
 Principles of protective relaying (classical and modern), current and voltage transformers, setting and testing or relaying elements, including differential, impedance, over/under current, voltage, and frequency relay types and/or elements, and their applications in protection of power system elements, including lines, generators, transformers, motors, and buses. Lecture 3 hours; laboratory 3 hours.
- EEE 146. Power Electronics Controlled Drives. 3 Units**  
**Prerequisite(s):** EEE 108, EEE 130.  
 Review thyristors, controlled rectifiers, DC choppers and inverters and pulse width modulation methods including space vector method. Control of DC drives and methods of control of induction synchronous motors including flux-vector methods and computer simulations will be studied.
- EEE 147. Power System Operation and Control Laboratory. 1 Unit**  
**Prerequisite(s):** EEE 141.  
 Computer simulation methods to describe power system behavior under steady state and dynamic conditions. Experiments conducted using MATLAB and Simulink for load flow in distribution lines, optimal power dispatch, synchronous machine transient behavior under short circuit conditions, transient stability, voltage and reactive power control, classical and modern load frequency control. Laboratory three hours.
- EEE 148. Power Electronics Laboratory. 1 Unit**  
**Prerequisite(s):** EEE 146; may be taken concurrently.  
 Solid state applications in power control. Diodes, rectifiers (single state and three phase), thyristors. Principle of phase controlled rectification, single phase and three phase converters. Power factor improvement. Three phase Pulse Width Modulation (PWM). AC voltage controllers. SPICE modeling. Strong design emphasis. EMTTP modeling. LabView graphics simulation. Microprocessor control of power electronics systems. UPS systems, power supplies, power quality monitoring.
- EEE 161. Applied Electromagnetics. 4 Units**  
**Prerequisite(s):** MATH 32, MATH 45, PHYS 11C, ENGR 17, and CSC 25.  
 Review of vector calculus. Electrostatic fields from lines, surface and volume charges by Coulomb's law, Gauss' law, Laplace's and Poisson's equations. Capacitance. Magnetostatic field calculations using Biot-Savart's law and Ampere's law. Inductance. Forces on moving charges. Magnetic materials. Electric and magnetic energy in fields. Faraday's law. Ideal transformer. Moving conductor in time-varying magnetic field. Displacement current. Charge-current continuity relation. Transmission line analysis, characteristic impedance, reflection coefficient and standing wave concepts. Introduction to Smith Chart solutions to matching problems.
- EEE 162. Applied Wave Propagation. 3 Units**  
**Prerequisite(s):** EEE 117, EEE 161.  
 Review of distributed circuit theory and the Smith chart. Impedance matching using series or shunt lumped and distributed circuits or near-quarterwave-matching sections. Noise temperature and noise figure. Scattering coefficient characterization of two-ports. Stability circles for high frequency transistors. Constant gain and noise figure circles. Basic antenna theory. Illustrated by their use for cell phones and other wireless systems.
- EEE 163. Traveling Waves Laboratory. 1 Unit**  
**Prerequisite(s):** EEE 117, EEE 162 (EEE 162 may be taken concurrently), and (GWAR Certification before Fall 09, or WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).  
 Selected experiments in the transmission and reflection of waves in coaxial lines and waveguides. Antenna impedance and pattern measurements. Laboratory three hours.

- EEE 165. Introduction To Optical Engineering. 3 Units**  
**Prerequisite(s):** EEE 161, EEE 180, EEE 185; EEE 185 may be taken concurrently.  
 Generation, propagation and detection of light. Fresnel equations, Snells law, diffraction, polarization and interference. Operating principles of LEDs, lasers, photodiodes and optical fibers. Introduction to optical communications systems, integrated optical devices, and optical instrumentation.
- EEE 166. Physical Electronics. 3 Units**  
**Prerequisite(s):** EEE 108.  
 Semiconductor physics, atomic models and crystal structures. Quantum theory, energy bands, motion of charge carriers, minority/majority carrier profiles and pn junctions. Manufacturing processes for and operating characteristics of diodes, bipolar transistors and field effect devices.
- EEE 167. Electro-Optical Engineering Lab. 1 Unit**  
**Prerequisite(s):** EEE 161, EEE 180, EEE 165; EEE 165 may be taken concurrently, and GEAR certification before Fall 09, WPJ score of 70+, or at least a C- in ENGL 109 M/W.  
 Provides senior level undergraduates with hands-on experience in optical engineering and design. Experiments involving laser characteristics, spectral radiometry, diffraction, polarization, modulation of light, holography and spatial filtering will be performed. Laboratory three hours.
- EEE 174. Introduction to Microprocessors. 4 Units**  
**Prerequisite(s):** Junior status, EEE 64.  
 Topics include: microcomputer systems, microprocessor architecture, machine and assembly language programming, timing operations, bus arbitration and exception processing logic, addressing modes, parallel and serial ports, memory, assemblers and development systems. The lab uses development systems and target systems in the Computer Engineering laboratory to assemble, link, test and debug and run various assignments. Lecture three hours; laboratory three hours.
- EEE 178. Introduction to Machine Vision. 3 Units**  
**Prerequisite(s):** EEE 180 or ME 172, or instructor approval.  
 Fundamental digital image processing and machine vision concepts and their application to the fields of robotics and automation. Topics include: digital image processing, image formation, two dimensional transforms, boundary descriptors, motion, camera calibration, vision for robot control, 3-D vision, and hardware architectures to support vision.
- EEE 180. Signals and Systems. 3 Units**  
**Prerequisite(s):** EEE 117; EEE 117 may be taken concurrently.  
 Rigorous development of the fundamental relationships governing time-domain and frequency-domain analysis of linear continuous-time and discrete-time systems. Topics include Fourier, Laplace and z-transforms, sampling theorem, modulation, system stability, and digital filters.
- EEE 181. Introduction to Digital Signal Processing. 3 Units**  
**Prerequisite(s):** EEE 64 or equivalent, EEE 180.  
 Focuses on the application of linear systems theory to design and analysis of digital signal processing systems. Discrete systems, the z transform, and discrete Fourier transform are reviewed. Design of infinite impulse response filters, finite impulse response filters, and digital spectral analysis systems is presented. Computer simulation is used to study the performance of filters and spectral analysis systems. Signal processing architectures are introduced. Lecture three hours.
- EEE 182. Digital Signal Processing Lab. 1 Unit**  
**Prerequisite(s):** EEE 180, EEE 181; EEE 181 may be taken concurrently.  
 Provides senior level undergraduate students with experience in the software/hardware design of discrete-time systems, and modern DSP techniques. Laboratory projects will include the following: spectral analysis of analog and digital signals, design of sampling and quantizer circuits, design and realization of IIR and FIR Digital Filters. Hardware projects will include acquisition, analysis, and filtering of speech, biomedical and video signals using Digital Signal Processors (DSPs).
- EEE 183. Digital and Wireless Communication System Design. 3 Units**  
**Prerequisite(s):** EEE 161, EEE 180; EEE 185 may be taken concurrently.  
 Review of fundamentals, probability, information, distortion by channel, sampling, pulse code modulation, companding, link power calculation, noise figure, pseudo noise. Matched filter detection of binary signals, bit error rate, inter-symbol interference, zero-forcing equalizers. Effects of additive white Gaussian noise in pulse code modulation, spread spectrum in multiple access, cellular radio and other wireless applications. Procedure for making design trade offs will be discussed.
- EEE 184. Introduction to Feedback Systems. 3 Units**  
**Prerequisite(s):** EEE 180.  
 Dynamic system modeling by transfer function and state-space methods using differential equation, time-response and frequency-response methods. Determination of steady-state errors due to step, ramp and parabolic inputs and disturbances for closed-loop systems. Mapping of block diagrams and state-space representations to signal flow graphs (SFG) as well as finding the transfer function of the system represented by the SFG by Mason's Rule. Closed-loop system stability is examined via poles and eigenvalues and by using the Routh-Hurwitz criterion. Introduction to observability and controllability of systems. Design of compensators for feedback systems using root-locus, frequency response and state-space methods. Introduction to digital control. Computer simulation methods such as MATLAB and SIMULINK are used to support the above subjects.
- EEE 185. Modern Communication Systems. 3 Units**  
**Prerequisite(s):** EEE 180, ENGR 120; ENGR 120 may be taken concurrently.  
 Review of signal and system analysis, sampling theorem and Nyquist's criteria for pulse shaping, signal distortion over a channel, study of digital and analog communication systems, line coding, signal to noise ratios, performance comparison of various communication systems.
- EEE 186. Communication Systems Laboratory. 1 Unit**  
**Prerequisite(s):** EEE 117 (EEE 185 may be taken concurrently), and (GEAR Certification before Fall 09, or WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).  
 Experimental study of modulation and demodulation in AM, FM, and digital communication systems, A/D and D/A conversion, measurement of power spectra, noise characterization in frequency domain.
- EEE 187. Robotics. 4 Units**  
**Prerequisite(s):** EEE 180 or equivalent, or instructor permission.  
 Lecture introduces principles of robotics and design of robot systems. Includes robot architectures, sensing position/velocity, digital circuit noise, actuator and path control, robot coordinate systems, kinematics, differential motion, computer vision/architectures, and artificial intelligence. Laboratory will apply lecture theory in design experiments utilizing five degree-of-freedom robots, an industrial robot, and vision systems.

- EEE 188. Digital Control System. 3 Units**  
**Prerequisite(s):** EEE 180, GWAR certification before Fall 09, WPJ score of 70+, or at least a C- in ENGL 109 M/W.  
 Intended to present treatment of the classical digital control with an introduction to modern digital control system in the state space. Z-transform as applied to discrete-time systems with transformation from the s-plane to the z-plane. Analyzes digital control systems using Nyquist and Bode plots and root-locus. Stability analysis of digital systems using Jury test, Routh Criterion, Nyquist and Bode plots. Design using root-locus and Bode plots introduced. Introduction to state-space and pole assignment. Finite-word length effects. MATLAB applications.
- EEE 189. Controls Laboratory. 1 Unit**  
**Prerequisite(s):** EEE 184 (EEE 184 may be taken concurrently), and (GWAR Certification before Fall 09, or WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).  
 Study, simulation and design of linear feedback control systems using digital control methods such as MATLAB and SIMULINK. Practical examples of analysis and compensation for closed loop systems.
- EEE 192A. Electrical Power Design Project I. 2 Units**  
**Prerequisite(s):** EEE 143 and any two of the following courses: EEE 141, EEE 142, EEE 144 (EEE 143 make be taken concurrently), and (GWAR Certification before Fall 09, or WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).  
 Concentrates on the planning, research and design aspects of electric power systems, including generation, transmission and distribution systems. Emphasis is placed on design philosophies, problem definition, research, project planning, written and oral communication skills, teamwork, development of specifications and effective utilization of available resources. Lecture one hour; laboratory three hours.
- EEE 192B. Electrical Power Design Project II. 2 Units**  
**Prerequisite(s):** EEE 192A, EEE 142, EEE 144; EEE 142 or EEE 144, but not both may be taken concurrently.  
 Continuation of EEE 192A. Students are expected to continue the power engineering design project begun the previous semester in EEE 192A. Final results of the project report will be presented orally to the class and invited faculty in a publicized seminar. Lecture one hour; laboratory three hours.
- EEE 193A. Product Design Project I. 2 Units**  
**Prerequisite(s):** EEE 108, EEE 109, EEE 130, EEE 161, EEE 174, EEE 180 (EEE 109 may be taken concurrently), GE Area 1 and (GWAR Certification before Fall 09, or WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).  
 Concentrates on the planning and design of electronic engineering devices, systems and software. Emphasis is placed on design philosophies, problem definition, project planning and budgeting, written and oral communication skills, teamwork, development of specifications, utilization of computer aided design systems, and effective utilization of available resources. Lecture one hour; laboratory three hours.
- EEE 193B. Product Design Project II. 2 Units**  
**Prerequisite(s):** EEE 193A.  
 Concentrates on design projects begun by the previous semester design teams in EEE 193A. The hardware will be completed, tested for the meeting of specifications and other requirements, and redesigned if necessary. Required software will be written, debugged and incorporated in a written report. The final results of the team project will be presented orally to the class and invited faculty in a publicized seminar. Lecture one hour; laboratory three hours.
- EEE 194. Career Development in Electrical and Electronic Engineering. 1 Unit**  
**Prerequisite(s):** EEE 192A or EEE 193A, may be taken concurrently.  
 Designed for Electrical and Electronic Engineering students making career decisions. Instruction will include effective career planning strategies and techniques including skill assessments, employment search strategy, goal setting, time management, interview techniques and resume writing. Lecture one hour.  
**Note:** Units earned cannot be used to satisfy major requirements.  
 Credit/No Credit
- EEE 195. Fieldwork in Electrical and Electronic Engineering. 1 - 3 Units**  
 Supervised work experience in Electrical and Electronic Engineering with public agencies or firms in the industry. Requires approval of a petition by the supervising faculty member and Department Chair.  
**Note:** May be repeated for credit.  
 Credit/No Credit
- EEE 195A. Professional Practice. 1 - 12 Units**  
**Prerequisite(s):** Instructor permission.  
 Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report.  
**Note:** Units earned cannot be used to satisfy major requirements.  
 Credit/No Credit
- EEE 195B. Professional Practice. 1 - 12 Units**  
**Prerequisite(s):** Instructor permission.  
 Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report.  
**Note:** Units earned cannot be used to satisfy major requirements.  
 Credit/No Credit
- EEE 195C. Professional Practice. 1 - 12 Units**  
**Prerequisite(s):** Instructor permission.  
 Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report.  
**Note:** Units earned cannot be used to satisfy major requirements.  
 Credit/No Credit
- EEE 195D. Professional Practice. 1 - 12 Units**  
**Prerequisite(s):** Instructor permission.  
 Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report.  
**Note:** Units earned cannot be used to satisfy major requirements.  
 Credit/No Credit
- EEE 196A. PCB Design Fundamentals. 1 Unit**  
**Prerequisite(s):** EEE 102, CPE 102 or EEE 108.  
 Printed circuit board (PCB) design fundamentals including library component creation, schematic capture, layout, routing, signal integrity and transmission line analysis, IEEE/IPC rules and standards, materials, manufacturing processes, and other physical properties of a PCB.



- EEE 196C. Applications of Power Electronics in Power Systems. 3 Units**  
**Prerequisite(s):** EEE 130 and EEE 141  
 Analysis methods for power electronics. Power electronic devices and their control methodologies. Electric machinery drives and flexible alternating current transmission systems (FACTS) devices with simulation and analysis of cases relevant to applications of power electronics in power systems.
- EEE 199. Special Problems. 1 - 3 Units**  
**Prerequisite(s):** Instructor permission.  
 Individual projects or directed reading.  
**Note:** Open only to students who appear qualified for independent work. Approval of the faculty sponsor and the academic advisor must be obtained before registering. May be repeated for credit.
- EEE 201. Research Methodology. 1 Unit**  
**Prerequisite(s):** Fully classified graduate status.  
 Research methodology, problem formulation and problem solving. Collective and individual study of selected issues and problems relating to fields of study in the Electrical and Electronic Engineering Graduate Program. Orientation to the requirements for Masters Thesis or Project in Electrical Engineering.  
 Credit/No Credit
- EEE 211. Microwave Engineering. 3 Units**  
**Prerequisite(s):** EEE 161; EEE 108 or instructor permission.  
 High-frequency passive electronic circuit design, specifically S-parameters, impedance matching, microstrip lines, filters, couplers and antennas.
- EEE 212. Microwave Engineering II. 3 Units**  
 Passive microwave components; power dividers, couplers and hybrids. Microwave filter design, periodic structures, image parameter and insertion loss methods for designing filters. Design of ferromagnetic components, isolators, phase shifters and circulators. Noise in microwave circuits.
- EEE 213. Microwave Devices and Circuits. 3 Units**  
**Prerequisite(s):** EEE 162.  
 Theory and application of electromagnetic radiation at microwave frequencies; study of microwave impedance and power measurement and characteristics of microwave circuit components, and electronic devices.
- EEE 214. Computer Aided Design for Microwave Circuits. 3 Units**  
**Prerequisite(s):** EEE 211 or instructor permission.  
 Introduction to design methodology of the basic building blocks of communication systems. Use of solid state devices in communications and microwave technology. Implementation of transmitter and receiver architectures. Impedance matching, S-parameters and small-signal, large-signal device operation. Design of transmitter and receiver components using a professional software tool. Design and simulations of gain and low noise amplifiers, detectors, mixers, power amplifiers and oscillators. Tradeoffs involved in the design of a complete transmitter and a receiver.
- EEE 215. Lasers. 3 Units**  
**Prerequisite(s):** EEE 180 and EEE 161 or instructor permission.  
 Review of electromagnetic theory. Ray tracing in an optical system, Gaussian beam propagation. Resonant optical cavities, study of excitation and lasing mechanisms in gas and semiconductor lasers. General characteristics and design of CW, Q switched and traveling wave lasers.
- EEE 221. Machine Vision. 3 Units**  
 Introduces the student to fundamental digital imaging processing concepts and their application to the fields of robotics, automation, and signal processing. Topics include: digital image filters, two dimensional transforms, boundary descriptors, Hough transform, automated visual inspection techniques, vision for robot control, 3-D vision, and hardware architectures to support vision.
- EEE 222. Electronic Neural Networks. 3 Units**  
 Current neural network architectures and electronic implementation of neural networks are presented. Basics of fuzzy logic is covered. Application software will be used to simulate training. Testing of various neural net architectures. Learning strategies such as back-propagation, Kohonen, Hopfield and Hamming algorithms will be explored. A final project requires the student to design, train and test a neural network for electronic implementation that solves a specific practical problem.
- EEE 225. Advanced Robot Control. 3 Units**  
**Prerequisite(s):** EEE 184 or equivalent.  
 Introduction to robot kinematics and dynamics followed by a comprehensive treatment of robot control. Topics include: independent joint control, multivariable control, force control, feedback linearization, real-time parameter estimation, and model-reference adaptive control.
- EEE 230. Analog and Mixed Signal Integrated Circuit Design. 3 Units**  
**Prerequisite(s):** EEE 109 or instructor permission.  
 Covers core topics and circuits important for analog and mixed-signal integrated circuits. Topics include: device structures and models, single-stage and differential amplifiers, current mirrors and active loads, operational amplifier design, stability and compensation, fully-differential circuits and common-mode feedback, noise in integrated circuits and the impact of IC processes on analog performance.
- EEE 231. Advanced Analog and Mixed Signal Integrated Circuit Design. 3 Units**  
**Prerequisite(s):** EEE 230 or consent of the instructor.  
 A companion course to EEE 230, covers additional topics important in analog and mixed-signal integrated circuit design. Topics include traditional issues such as device matching and analog layout techniques, as well as important building blocks such as bandgap references and bias circuits. Also included are current-mode techniques such as high-speed current-mode logic (CML), and an introduction to noise in integrated circuits. Circuit and layout projects are assigned using CAD software.
- EEE 232. Key Mixed-Signal Integrated Circuit Building Blocks. 3 Units**  
**Prerequisite(s):** EEE 230 or consent of instructor.  
 Covers key mixed-signal integrated circuit building blocks most often used in modern ICs. Topics covered include data converter fundamentals, comparators, and important circuit architectures for Analog-to-Digital Converters (ADCs), Digital-to-Analog Converters (DACs), and Phase-Locked Loops (PLLs).
- EEE 234. Digital Integrated Circuit Design. 3 Units**  
**Prerequisite(s):** EEE 230 or instructor permission.  
 The background and techniques needed to design and layout digital circuits at the transistor level for mixed-signal integrated circuits are covered. Topics include the design, layout and characterization of digital logic gates at the transistor level, typical CMOS process flows, device models and physics, and chip level considerations.

- EEE 235. Mixed-Signal IC Design Laboratory. 1 Unit**  
**Prerequisite(s):** EEE 230 or consent of the instructor.  
 Methods to develop successful mixed-signal integrated circuits using an industrial design methodology and computer-aided design tools. Proven design techniques presented; hands-on experience gained through each student designing their own integrated circuit. Communications skills developed through periodic presentations, including reviews for the circuit architecture, design and layout.
- EEE 236. Advanced Semiconductor Devices. 3 Units**  
 Semiconductor device modeling, including the application of the continuity equation and Poissons equation to abrupt and graded p/n junctions, semiconductor/metal contacts, junction field effect transistors (JFET), metal-oxide-semiconductor transistors (MOSFET), and bipolar junction transistors (BJT). Special topics include compound semiconductor devices and heterostructures.
- EEE 238. Advanced VLSI Design-For-Test I. 3 Units**  
**Prerequisite(s):** CPE 151 and CPE 166.  
 Focus on integrated circuit design-for-test-techniques; semiconductor reliability factors and screening; semiconductor fabrication processes, device physics and related performance limitations; quantifying cost/quality tradeoffs; IC manufacturing flows and high-accuracy parametric test methods.
- EEE 239. Advanced VLSI Design-For-Test II. 3 Units**  
**Prerequisite(s):** EEE 238.  
 Advanced topics in VLSI testing and Design-For-Test applications. Memory-specific test methodology and special features of memory designs employed in high volume manufacturing for improved testability, yield, and reliability. VLSI failure modes, their detection and prevention. Application of trim, redundancy, wear-leveling, and error correction.
- EEE 241. Linear Systems Analysis. 3 Units**  
**Prerequisite(s):** EEE 180 or equivalent.  
 Analyzes linear systems in the state-space. System realization and modeling, solutions of linear systems, stability including the method of Lyapunov, controllability and observability, state feedback and observers for both continuous and discrete-time systems. Familiarity with MATLAB is required.
- EEE 242. Statistical Signal Processing. 3 Units**  
 Introduces the student to modern statistical approaches for solving electronic system noise problems. A few of the topics covered are: Stochastic processes, Wiener and Kalman filters, linear prediction, lattice predictors and singular-value decomposition.
- EEE 243. Applied Stochastic Processes. 3 Units**  
**Prerequisite(s):** ENGR 120.  
 Introduction to sequence of random variables and multivariable distributions; models of stochastic processes; stationary stochastic processes and their applications; Markov processes, Markov chains, continuous Markov chains; renewal processes; birth-death processes; time-series applications in stochastic processes in filtering, reliability and forecasting, prediction and control.
- EEE 244. Electrical Engineering Computational Methods and Applications. 3 Units**  
**Prerequisite(s):** EEE 180.  
 Computational methods for solving problems in engineering analysis. Topics include variational methods, finite-difference analysis, optimization methods, and matrix methods. Focuses predominantly on applications of the methods, and students are required to solve real-world, engineering problems on the computer.
- EEE 245. Advanced Digital Signal Processing. 3 Units**  
**Prerequisite(s):** EEE 174, EEE 181 or equivalent.  
 Advanced signal processing topics include: multirate signal processing, adaptive filter design and analysis, spatial filtering and the application of FIR filter theory to beamforming. Applications of digital signal processing in communication systems, radar systems, and imaging systems are covered. Hardware and software topics, including current products and the incorporation of VLSI are included. Lecture.
- EEE 246. Advanced Digital Control. 3 Units**  
**Prerequisite(s):** EEE 241.  
 Review of digital control methods using transform techniques. State-variable representation and design of digital control systems, state-space compensators and tracking systems, polynomial equations approach, LQR and LQG discrete-time control and identification, and introduction to adaptive self-tuning regulators.
- EEE 249. Advanced Topics in Control and Systems. 3 Units**  
 Topics from recent advances in control, systems and robotics control selected from IEEE Journals and related professional publications. May be taken twice for credit.
- EEE 250. Advanced Analysis of Faulted Power Systems. 3 Units**  
**Prerequisite(s):** EEE 141 or equivalent.  
 Computation of phase and sequence impedances for transmission lines, machines, and transformers; sequence capacitance of transmission lines; applications of symmetrical components; changes in symmetry; analysis of simultaneous faults by two-port network theory and matrix transformations; analytical simplification for shunt and series faults; solution of the generalized fault diagrams; computer solution methods using the admittance and impedance matrices.
- EEE 251. Power System Economics and Dispatch. 3 Units**  
**Prerequisite(s):** EEE 141 or equivalent.  
 Study of a number of engineering and economic matters involved in planning, operating, and controlling power generation and transmission systems in electric utilities. Effects of hydro and nuclear plants on system economics. Economic and environmental constraints. Theoretical developments and computer methods in determining economic operation of interconnected power systems with emphasis on digital computers.
- EEE 252. Power System Reliability and Planning. 3 Units**  
**Prerequisite(s):** EEE 142 or equivalent.  
 Power system economics, generation, transmission and distribution reliability. Production costing and generation planning, transmission planning.
- EEE 253. Control and Stability of Power Systems. 3 Units**  
**Prerequisite(s):** EEE graduate standing.  
 The fundamental concepts of control and stability in power systems. Topics include: power systems dynamics and linearized models, small and large disturbances, voltage and frequency stability. Introduction to power systems dynamic simulation for stability studies using CAD tools.
- EEE 254. Large Interconnected Power Systems. 3 Units**  
**Prerequisite(s):** EEE 142.  
 Computer control, optimization and organization of large power systems. Load and frequency control, voltage control, large load flow and contingency studies. Introduction to state estimation and load forecasting.

- EEE 255. Future Power Systems and Smart Grids. 3 Units**  
**Prerequisite(s):** EEE 141, EEE 146, EEE 180, and EEE 250 or instructor permission.  
 Future power systems from component and system perspectives. Smart grids, micro-grids, and interactive power systems using renewable resources and energy storage elements. National standards for certification of distributed generation involving machine-based and inverter-based technologies. Essential elements of advanced sensing, communications and information technology and their roles in adaptive automation, control, protection, and security.
- EEE 256. Advanced Power Systems Protection. 3 Units**  
**Prerequisite(s):** EEE 141; EEE 145 or instructor permission.  
 Advanced concepts and schemes used in power system protection including the various protective schemes used for transmission lines, transformers, machines, and other elements of a large interconnected power system. Concepts in digital and microprocessor based relay design and analysis of typical protection subsystems, in conjunction with the protection of the power system as a whole.
- EEE 257. Wind Energy Electrical Conversion Systems. 3 Units**  
**Prerequisite(s):** Fully classified graduate standing in EEE or instructor permission  
 Fundamentals of current technologies and methods in wind energy conversion systems, including turbines, generators and converters as well as control and integration of these devices in power grids. Topics include: power conversion, grid converters for wind systems, system integration, methods for power, voltage and frequency control, and wind farms simulation and aggregation methods.
- EEE 259. Advanced Topics in Power Systems. 3 Units**  
**Prerequisite(s):** EEE 142.  
 Topics from recent advances in Electrical Power Engineering selected from IEEE Journal on "Power Systems" and "Power Systems Delivery." May be taken twice for credit.
- EEE 260. Statistical Theory of Communication. 3 Units**  
**Prerequisite(s):** EEE 185.  
 Review of Fourier analysis and theory of probability, random processes, optimum filtering, performance of analog and digital communication systems in the presence of noise, system optimization.
- EEE 261. Information Theory, Coding, and Detection. 3 Units**  
**Prerequisite(s):** EEE 185.  
 Signal space concepts, optimum M-ary communication systems, MAP estimation of continuous waveform parameters, information theory, coding.
- EEE 262. Wireless Communications Systems. 3 Units**  
**Prerequisite(s):** EEE 185 or instructor permission.  
 Wireless communication techniques, systems and standards. Topics include cellular systems, RF transmission and analog/digital modulation techniques. Modern techniques such as multiple access and spread spectrum systems. Channel coding and diversity will also be included.
- EEE 264. Advanced Topics in Wireless Communications. 3 Units**  
**Prerequisite(s):** EEE 262 or instructor permission.  
 Advanced theoretical and practical aspects of modern wireless communications. Specific topics include: advanced cellular concepts, modern small-scale and large-scale propagation models, complex equalization and diversity system design, 3G (third generation) wireless networks, Bluetooth and Personal Area Networks (PANs), GPRS (General Packet Radio Service) and wireless measurement techniques.
- EEE 265. Optoelectronic Engineering. 4 Units**  
**Prerequisite(s):** Graduate standing or instructor permission.  
 Generation, propagation and detection of light. Fresnel equations, Snell's law, diffraction, polarization, and interference. Operating principles of LEDs, lasers, photodiodes, optical fibers, photovoltaic devices. Introduction to optical communications systems and optical instrumentation.  
**Note:** EEE 265 and EEE 165 may not be both taken for graduate credit.
- EEE 267. Fiber Optic Communications. 3 Units**  
**Prerequisite(s):** EEE 185 or instructor permission.  
 Fundamentals of modern lightwave communication systems, sources detectors and optical fibers. Study of dispersion in Step Index, Graded Index and Single Mode Optical Fibers. Intensity Modulated Direct Detection systems (IMDD) and Coherent Fiber Optic Systems (COFOCS). Performance evaluation and design considerations. Wavelength division multiplexing, Local Area Networks, optical amplifiers and photonic switching.
- EEE 270. Advanced Topics in Logic Design. 4 Units**  
**Prerequisite(s):** EEE Graduate Student Standing.  
 Synchronous and asynchronous state machines. Timing issues in high-speed digital design. Design of a complex system using VHDL and Verilog Hardware Description Languages in a CAD environment. Automation toolsets to synthesize projects containing a hierarchy of modules into Field Programmable Gate Arrays (FPGAs). Simulations using CAD tools to verify the design before implementation on rapid prototyping boards in the lab. Lecture 3 hours; laboratory 3 hours.
- EEE 272. High Speed Digital System Design. 3 Units**  
**Prerequisite(s):** EEE 161, fully classified graduate standing and instructor permission.  
 Theoretical topics and practical applications relating to high speed digital systems. Review of basic transmission line theory, crosstalk, impact of PCB traces, vias, and connectors on signal integrity, return current paths, simultaneous switching noise, high frequency power delivery, high speed timing budgets, high speed bus design methodologies, radiated emissions, and system noise.
- EEE 273. Hierarchical Digital Design Methodology. 3 Units**  
**Prerequisite(s):** EEE 64 or equivalent.  
 Hierarchical digital design course that includes: State machine design, Programmable Logic Devices, digital simulation techniques, digital interface, design with ASIC (Application Specific Integrated Circuits), programmable Gate Arrays, and designing with Gas high speed logic devices. Problems with EMI, RFI and EMC will be presented along with design guidelines. Lecture three hours.  
 Cross Listed: CSC 273; only one may be counted for credit.
- EEE 274. Advanced Timing Analysis. 3 Units**  
**Prerequisite(s):** EEE 273, CSC 273, CPE 273 or instructor permission.  
 Timing analysis of Application Specific Integrated Circuit (ASIC) designs: Topics include ASIC design methodology, static timing analysis, timing design constraints, design reports, clock timing issues, timing exceptions, operating conditions, hierarchical analysis, analyzing designs with asynchronous logic, performance measurement and power issues.  
 Cross-listed: CPE 274; only one may be counted for credit.

**EEE 280. Advanced Computer Architecture. 3 Units****Prerequisite(s):** CSC 205 or instructor permission.

Introduces computer classification schemes, structures of uni- and multi-processor systems, parallelism in uniprocessor systems, design and performance analysis of pipelined and array processors; survey and analysis of interconnection networks and parallel memory organizations; programming issues of multiprocessor systems; and fault tolerant computing and design for testability.

Cross Listed: CSC 280; only one may be counted for credit.

**EEE 285. Micro-Computer System Design I. 3 Units****Prerequisite(s):** EEE 174 or CPE 185.

Focuses on: design of the microprocessor based computer system, study of bus structures, interrupt schemes, memory interfacing, timing, bus arbitration, system architecture, data communications, introduction to multiprocessor systems, and software development.

**EEE 286. Microcomputer System Design II. 3 Units****Prerequisite(s):** EEE 285 or CPE 186.

Includes PCI and PCI express bus specifications/architecture, PCI bridges transaction ordering, PCI express transactions and handshaking protocols, electromagnetic interference, methods of eliminating interference, shielding grounding, balancing, filtering, isolation, separation, orientation, cancellation techniques and cable design. Involves design projects and research presentations on PCI and PCI Express Bridge.

**EEE 296T. Digital Speech Processing. 3 Units****Prerequisite(s):** EEE 181 or instructor permission.

The objective of this course is to cover the digital processing of speech signals. Topics include speech production and perception, speech processing in the time frequency domains. Short-time energy and Short-time Fourier analysis, homomorphic and linear predictive coding methods. Also covered are speech coding, basic introduction of text-to-speech synthesis and speech recognition.

Cross listed: CPE 296T.

**EEE 299. Special Problems. 1 - 3 Units****Prerequisite(s):** Instructor permission.

Open to qualified students who wish to pursue problems of their own choice. Projects must have approval and supervision of a faculty advisor.

**EEE 500. Culminating Experience. 1 - 6 Units****Prerequisite(s):** Advanced to candidacy and permission of the graduate coordinator, and GEAR certification before Fall 09, WPJ score of 70+, or at least a C- in ENGL 109 M/W.

Completion of a thesis, project or comprehensive examination. Credit given upon successful completion of one of the following plans: Plan A: Master's Thesis, 5 units; Plan B: Master's Project, 2 units; or Plan C: Comprehensive Examination.