ELECTRICAL AND ELECTRONIC ENGINEERING (EEE)

EEE 64. Introduction to Logic Design. 4 Units
Prerequisite(s): CSC 15 or CSC 25 or ENGR 50
General Education Area/Graduation Requirement: Understanding Personal Development (E)
Term Typically Offered: Fall, Spring, Summer

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.

EEE 64W. Introduction to Logic Design Workshop. 1 Unit
Corequisite(s): EEE 64.
Term Typically Offered: Fall, Spring
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.

Credit/No Credit

EEE 108. Electronics I. 3 Units
Prerequisite(s): EEE 117.
Corequisite(s): EEE 108L.
Term Typically Offered: Fall, Spring
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.

EEE 108L. Electronics I Laboratory. 1 Unit
Corequisite(s): EEE 117, EEE 117L
Term Typically Offered: Fall, Spring
Characteristics and applications of semiconductor devices including diodes, BJTs and FETs, and analog integrated circuits including opamps. Introduction to circuit simulation using professional computer-aided design (CAD) software. Laboratory three hours.

EEE 109. Electronics II. 4 Units
Prerequisite(s): 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.
Term Typically Offered: Fall, Spring
Differentiation 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.

EEE 110. Advanced Analog Integrated Circuits. 3 Units
Prerequisite(s): EEE 109 or consent of instructor.
Term Typically Offered: Fall only
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.

EEE 111. Advanced Analog Integrated Circuits Laboratory. 1 Unit
Prerequisite(s): EEE 109; either EEE 110 or EEE 230. EEE 110 or EEE 230 may be taken concurrently.
Term Typically Offered: Fall only
Circuit design, mask design, and simulation of integrated circuits. Use of CAD software to prepare design for fabrication. Individual and group design projects. Laboratory three hours.

EEE 117. Network Analysis. 3 Units
Prerequisite(s): ENGR 17, MATH 45, and PHYS 11C
Corequisite(s): EEE 117L.
Term Typically Offered: Fall, Spring
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.

EEE 120. Electronic Instrumentation. 4 Units
Prerequisite(s): EEE 108, EEE 117; EEE 108 may be taken concurrently.
Term Typically Offered: Fall, Spring
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.

EEE 122. Applied Digital Signal Processing. 3 Units
Prerequisite(s): EEE 117, EEE 180.
Term Typically Offered: Fall only
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.
ECE 130. Electromechanical Conversion. 3 Units
Prerequisite(s): EEE 117 and EEE 161
Term Typically Offered: Fall, Spring

Magnetic circuits and principles of electromechanical energy conversion, transformers, DC machines, asynchronous AC machines, synchronous AC machines, introduction to special machines.

ECE 131. Electromechanics Laboratory. 1 Unit
Prerequisite(s): EEE 131, 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).
Term Typically Offered: Fall, Spring

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.

ECE 135. Renewable Electrical Energy Sources and Grid Integration. 3 Units
Prerequisite(s): EEE 130.
Term Typically Offered: Spring only

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.

ECE 136. Smart Electric Power Grid. 3 Units
Corequisite(s): EEE 142 or EEE 144.
Term Typically Offered: Spring only


ECE 137. Applications of Power Electronics in Power Systems. 3 Units
Prerequisite(s): EEE 130 and EEE 141
Term Typically Offered: Spring only

Analysis methods for power electronics. Power electronic devices and their control methodologies. Electric machinery drives and flexible alternating current transmission systems (FACTS) devices simulation of cases relevant to applications of power electronics in power systems.

ECE 141. Power System Analysis I. 3 Units
Prerequisite(s): EEE 117 and EEE 161
Term Typically Offered: Fall, Spring


ECE 142. Power System Analysis II. 3 Units
Prerequisite(s): EEE 130, EEE 141, and EEE 184 (EEE 184 may be taken concurrently).
Term Typically Offered: Fall, Spring

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.

ECE 143. Power System Laboratory. 3 Units
Prerequisite(s): EEE 130, EEE 141 and (WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).
Term Typically Offered: Fall, Spring

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.

ECE 144. Electric Power Distribution. 3 Units
Prerequisite(s): EEE 130.
Term Typically Offered: Fall only

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.

ECE 145. Power System Relay Protection and Laboratory. 4 Units
Prerequisite(s): EEE 141
Term Typically Offered: Fall only

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.

ECE 146. Power Electronics Controlled Drives. 3 Units
Prerequisite(s): EEE 108, EEE 130.
Term Typically Offered: Fall, Spring

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.

ECE 147. Power System Operation and Control Laboratory. 1 Unit
Prerequisite(s): EEE 142.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring


EEE 161. Applied Electromagnetics. 4 Units
Prerequisite(s): MATH 32, MATH 45, PHYS 11C, ENGR 17, and CSC 25.
Term Typically Offered: Fall, Spring


EEE 162. Applied Wave Propagation. 3 Units
Prerequisite(s): EEE 117, EEE 161.
Term Typically Offered: Fall, Spring

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 (WPJ score of 70+, or at least a C- in ENGL 109 M/W)
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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 and CHEM 1E or CHEM 1A
Term Typically Offered: Spring only

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 (WPJ score of 70+, or at least a C- in ENGL 109 M/W)
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring, Summer

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.
Term Typically Offered: Spring only

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 & Systems. 3 Units
Prerequisite(s): ENGR 17, MATH 45, EEE 117; EEE 117 may be taken concurrently.
Term Typically Offered: Fall, Spring

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, EEE 180.
Term Typically Offered: Spring only

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.
EEE 182. Digital Signal Processing Lab. 1 Unit
Prerequisite(s): EEE 180, EEE 181; EEE 181 may be taken concurrently.
Term Typically Offered: Spring only

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.
Term Typically Offered: Fall only

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.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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 (GWAR Certification before Fall 09, or WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall only

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, WPJ score of 70+, or at least a C- in ENGL 109 M/W.
Term Typically Offered: Spring only


EEE 189. Controls Laboratory. 1 Unit
Prerequisite(s): EEE 184 (EEE 184 may be taken concurrently), and (WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).
Term Typically Offered: Spring only

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 141, EEE 142, EEE 143; EEE 143 may be taken concurrently. WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W.
Term Typically Offered: Fall, Spring

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 142, EEE 143, and EEE192A.
Term Typically Offered: Fall, Spring

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 A and (WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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 195E. Professional Practice. 1 - 12 Units
Prerequisite(s): Instructor permission.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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 199. Special Problems. 1 - 3 Units
Prerequisite(s): Instructor permission.
Term Typically Offered: Fall, Spring

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.

Credit/No Credit
EEE 201. Research Methodology. 2 Units
Prerequisite(s): Graduate standing or instructor permission
General Education Area/Graduation Requirement: Writing Intensive Graduation Requirement (WI)
Term Typically Offered: Fall, Spring

Immersion in the discourse of Electrical and Electronic Engineering: genres, literacies, stylistic conventions, research methodology. Collective and individual study of selected issues and problems relating to fields of study in Electrical and Electronic Engineering. Orientation to the requirements for the master's degree culminating experience. Note: Must be taken in the first semester of the graduate program.

EEE 211. Microwave Engineering. 3 Units
Prerequisite(s): EEE 161; EEE 108 or instructor permission.
Term Typically Offered: Fall, Spring

High-frequency passive electronic circuit design, specifically S-parameters, impedance matching, microstrip lines, filters, couplers and antennas.

EEE 212. Modern Antenna Design. 3 Units
Prerequisite(s): EEE 161.
Term Typically Offered: Fall, Spring


EEE 213. Microwave Devices and Circuits. 3 Units
Prerequisite(s): EEE 162.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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 220. Machine Vision. 3 Units
Term Typically Offered: Spring only

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 221. Advanced Robot Control. 3 Units
Prerequisite(s): EEE 184 or equivalent.
Term Typically Offered: Fall only

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.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall only

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.
Term Typically Offered: Spring only

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).
### Electrical and Electronic Engineering (EEE)

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<tr>
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Characteristics of modern power transmission systems, Transmission line parameters, Steady-state, Dynamic and Transient behavior of AC/DC transmission systems, Flexible AC Transmission Systems (FACTS), High-Voltage Direct Current (HVDC) systems, Analysis of faulted transmission systems and AC/DC hybrid grids.

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.

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.

Computer control, optimization and organization of large power systems. Loan and frequency control, voltage control, large load flow and contingency studies. Introduction to state estimation and load forecasting.

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.

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.

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.

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.

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.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring


EEE 270. Advanced Topics in Logic Design. 4 Units
Prerequisite(s): EEE 161, fully classified graduate standing and instructor permission.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Spring only

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.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

Introduces computer classification schemes, structures of uni- and multiprocessor 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.
Term Typically Offered: Fall, Spring

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.
Term Typically Offered: Fall, Spring

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 296C. Transients in Power Systems. 3 Units
Prerequisite(s): EEE 130 and EEE 141
Term Typically Offered: Fall, Spring

Transients in electric power systems due to shunt capacitor switching, voltage flicker and nonlinear loads such as electric arc furnaces. Lightning surges and their effect on the power system health and operation. Transformer inrush currents and motor starting. The knowledge of EEE 130 and EEE 141 or equivalent courses is required for taking this course.

Credit/No Credit
EEE 296T. Digital Speech Processing. 3 Units

**Prerequisite(s):** EEE 181 or instructor permission.

**Term Typically Offered:** Fall, Spring

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.

**Term Typically Offered:** Fall, Spring

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 GWAR certification before Fall 09, WPJ score of 70+, or at least a C- in ENGL 109 M/W.

**Term Typically Offered:** Fall, Spring

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.