ELECTRICAL & COMPUTER ENGR (ECE)

ECE 1010 Foundations of Electrical and Computer Engineering (2 credits)
Introductory course for incoming students with little or no fundamental electrical/computer engineering knowledge. Includes coverage of basic analog and digital circuits. Lab assignments also included.
Coreqs: MATH 1143 or MATH 1170

ECE 2040 (s) Special Topics (1-16 credits, max 99)
Credit arranged

ECE 2100 Electrical Circuits I (3 credits)
Intro to d. c. and transient electrical circuits; mesh and nodal analysis; dependent sources; circuit theorems; transient analysis with differential equations. Three lectures and one recitation per week.
Prereqs: MATH 1750 with a grade of 'C' or better
Coreqs: ECE 2110, MATH 3100 and PHYS 2120 and PHYS 2120L

ECE 2110 Electrical Circuits Lab I (1 credit)
Lab to accompany ECE 2100. Lab experiments and computer simulations. One 3-hour lab per week.
Coreqs: ECE 2100 and PHYS 2120 and PHYS 2120L

ECE 2120 Electrical Circuits II (3 credits)
Continuation of ECE 2100. Intro to sinusoidal steady state circuits; time and frequency domain analysis; Laplace transforms; Fourier series; transfer functions; Bode plots, filters. Three lectures and one recitation per week.
Prereqs: ECE 2100, MATH 3100, and PHYS 2120 and PHYS 2120L; a grade of C or better is required for all prerequisite courses
Coreqs: ECE 2130

ECE 2130 Electrical Circuits II Lab (1 credit)
Lab to accompany ECE 2120. Continuation of ECE 2110. Lab experiments and computer simulations. One 3-hour lab per week.
Prereqs: ECE 2110 and PHYS 2120 and PHYS 2120L
Coreqs: ECE 2120

ECE 2400 Digital Logic (3 credits)
Number systems, truth tables, logic gates, flip-flops, combinational and synchronous sequential circuits; intro to digital systems and basic microprocessor architecture.
Prereqs: PHYS 2120 and PHYS 2120L
Coreqs: ECE 2410

ECE 2410 Logic Circuit Lab (1 credit)
Lab to accompany ECE 2400.
Prereqs: PHYS 2120 and PHYS 2120L
Coreqs: ECE 2400

ECE 2920 Sophomore Seminar (0 credits, max 99)
Curriculum options, elective courses, preparation for graduate study, professional ethics, and current technical topics. Field trip may be required. Graded Pass/Fail.

ECE 2990 (s) Directed Study (1-16 credits, max 99)
Credit arranged

ECE 3100 Microelectronics I (3 credits)
Operational amplifier fundamentals and applications, introduction to electronic devices such as diodes, bipolar junction transistor (BJT) and metal oxide semiconductor field effect transistors (MOSFET), large and small-signal modeling of non-linear electronic devices, DC and small-signal analysis of circuits with non-linear electronic devices, biasing of electronic circuits using passive and active elements such as current mirrors, frequency response of electronic circuits, introduction to the analysis, design, and applications of electronic circuits such as rectifiers, power supplies, and low-frequency single-stage amplifiers. Practical limitations of amplifiers of electronic circuits.
Prereqs: ECE 2120 and ECE 2130
Coreqs: ECE 3110

ECE 3110 Microelectronics I Lab (1 credit)
Lab to accompany ECE 3100.
Coreqs: ECE 3100

ECE 3190 Background Study in Electronics (3 credits)
Not applicable toward any UI undergraduate degree; valid only for removal of electronics (ECE 3100) deficiency for graduate students who do not have BSEE background. See ECE 3100 for description. Graded Pass/Fail based on comprehensive exam at completion of course. Graded Pass/Fail. Typically Offered: Varies.
Prereqs: Permission

ECE 3200 Energy Systems I (3 credits)
Single-phase AC measurements, transformer parameters, transformer performance, rotating DC machines, DC-DC PE converters. Three lectures per week.
Prereqs: ECE 2120 and PHYS 2120 and PHYS 2120L
Coreqs: ECE 3210

ECE 3210 Energy Systems I Laboratory (1 credit)
Lab to accompany ECE 3200. Lab experiments and computer simulations. One 3-hour lab per week.
Prereqs: ECE 2130, PHYS 2120, PHYS 2120L, MATH 3100
Coreqs: ECE 3200

ECE 3290 Background Study in Energy Systems (3 credits)
Not applicable toward any UI undergraduate degree; valid only for removal of electrical machinery (ECE 3200) deficiency for graduate students who do not have BSEE background. See ECE 3200 for description. Graded P/F based on comprehensive exam at completion of course. Graded Pass/Fail.
Prereqs: Permission

ECE 3300 Electromagnetic Theory (3 credits)
Vector mathematics; charge and current; fields as forces; work, potential and electro-motive force; Faraday's law of induction; Gauss's and Ampere's laws; material modeling; waves in isotropic media.
Prereqs: MATH 2750, MATH 3100, and PHYS 2120 and PHYS 2120L
Coreqs: ECE 3310

ECE 3310 Electromagnetics Laboratory (1 credit)
Lab to accompany ECE 3300. Lab experiments and computer simulations. One 3-hour lab per week.
Prereqs: MATH 2750, MATH 3100; PHYS 2120 and PHYS 2120L
Coreqs: ECE 3300

ECE 3400 Microcontrollers (3 credits)
Introduction to use of embedded microcontrollers and microprocessors; processor architecture; programming; use of development systems and/or emulators for system testing and debugging; software and hardware considerations of processor interfacing for I/O and memory expansion; programmed and interrupt driven I/O techniques.
Prereqs: ECE 2120, ECE 2130, ECE 2400, ECE 2410, and CS 1112 or CS 1120
Coreqs: ECE 3410

ECE 3410 Microcontrollers Lab (1 credit)
Lab to accompany ECE 3400.
Coreqs: ECE 3400

ECE 3490 Background Study Digital Logic (3 credits)
Not applicable toward any UI undergraduate degree; valid only for removal of digital computer fundamentals (ECE 2400) deficiency for graduate students. See ECE 2400 for description. Graded Pass/Fail.

ECE 3500 Signals and Systems I (3 credits)
Continuous and discrete, linear time invariant systems. Continuous and discrete linear time invariant systems. Differential and difference equations. Convolution integrals and sums. Fourier and Laplace transforms. Discrete time Fourier transforms and Z transforms. Emphasis on practical applications to engineering systems.
Prereqs: ECE 2120 and MATH 3100
Coreqs: ECE 3510

ECE 3510 Signals and Systems I Lab (1 credit)
Laboratory to accompany ECE 3500. Software and hardware laboratories. Introduction to Matlab.
Coreqs: ECE 3500

ECE 3590 Background Study in Signals and Systems Analysis (3 credits)
Not applicable toward any UI undergrad degree; valid only for removal of signals and systems analysis (ECE 3500) deficiency for grad students who do not have BSEE background. See ECE 3500 for description. Graded Pass/Fail based on comprehensive exam at completion of course. Graded Pass/Fail. Typically Offered: Varies.
Prereqs: Permission

ECE 3980 Electrical Engineering Cooperative Internship (1-3 credits, max 99)
Credit arranged. Supervised internship in industry in professional engineering settings, integrating academic study with work experience; requires weekly progress reports, a final written report, and a talk/presentation and additional details to be worked out with the faculty supervisor. Cannot be counted as a technical elective toward the B. S. E. E. or B. S. Comp. E. Graded Pass/Fail.
Prereqs: Permission

ECE 4040 (s) Special Topics (1-16 credits, max 99)
Credit arranged

ECE 4100 Microelectronics II (3 credits)
Introduction to analog integrated circuit (IC) implementation and design, differential and common-mode signal concepts, differential amplifiers, multistage amplifiers, operational amplifier design, frequency response of electronic circuits, feedback in electronic circuits, large-signal/power amplifiers, advanced current sources and mirrors, and fundamentals of analog filters.
Prereqs: ECE 3100 and ECE 3110; or Permission

ECE 4150 Analog Integrated Circuit Design (3 credits)
Joint-listed with ECE 5150
Analog integrated circuit (IC) analysis, design, simulation, and layout, advanced biasing techniques, voltage references and regulators, operational amplifiers, frequency compensation techniques, noise analysis in analog circuits, and continuous-time integrated circuit filter design. Additional projects/assignments required for graduate credit.
Prereqs: ECE 4100 or Permission Cooperative: open to WSU degree-seeking students.

ECE 4180 Introduction to Electronic Packaging (3 credits)
Joint-listed with ECE 5180
This course serves as an introduction to electronic packaging and "back-end" microelectronic processes. Topics include substrate design & fabrication, SMT & first level assembly, clean room protocol, thermal design, simulation, and process considerations. Additional project work will be required for students enrolled in ECE 5180.
Prereqs: ECE 3100 Cooperative: open to WSU degree-seeking students.

ECE 4190 Image Sensors and Systems (3 credits)
Joint-listed with ECE 5160
This course introduces various concepts and fundamentals related to semiconductor image sensors. Topics cover light production and detection, video image formats, image sensor characteristics and performance metrics, basic and advanced operation principals and types of semiconductor image sensors (CCD and CMOS), noise in imagers, image and color processing, and issues related to camera system design, integration and signal processing. Additional projects/assignments required for graduate credit.
Prereqs: ECE 3100 Cooperative: open to WSU degree-seeking students.

ECE 4200 Energy Systems II (3 credits)
Three-phases, three-phase transformers, winding theory, rotating waves, steady state operation of three-phase synchronous and steady state operation of single and three-phase induction machines, and AC drives. Labs: three-phase measurements, three-phase transformers, synchronous machines, induction machines. ECE 4200 cannot be counted as a graduate depth area course.
Prereqs: ECE 3200 and ECE 3210

ECE 4210 Introduction to Power Systems (3 credits)
One line diagrams, regulating transformers, calculation of transmission line parameters, line models, Ybus, power flow, power flow studies using commercial software, contingency studies, and power system control. Typically Offered: Fall.
Prereqs: ECE 4200

ECE 4220 Power Systems Analysis (3 credits)
Balanced and unbalanced faults, Zbus methods, transient generator models, stability analysis, fault analysis using commercial software, and introduction to power system protection. Typically Offered: Spring.
Prereqs: ECE 4210

ECE 4270 Power Electronics (3 credits)
Characteristics, limitations, and application of solid state power devices; practical aspects of power electronic converters, including rectifiers and inverters; choppers, AC phase control, and device gating techniques.
Coreqs: ECE 4200 Cooperative: open to WSU degree-seeking students

ECE 4300 Microwave and Millimeter Wave Circuits (3 credits)
Telegrapher's and wave equations; characteristic impedance, wave velocity and wave number; physical transmission lines, including coax, microstrip and stripline; circuit analysis techniques, reflection coefficient and power flow; impedance analysis, impedance matching techniques and Smith Chart; S-parameters; Wilkinson power dividers, circulators and hybrid couplers; transformers and filters.
Prereqs: ECE 3300 or Permission

ECE 4320 Propagation of Wireless Signals (3 credits)
Maxwell's Equations, including Poynting's vector and Poynting's theorem; Wave equation with solutions, Helmholz equation, plane waves; Reflection and refraction; Theory of guided waves, ray theory and mode theory; Atmospheric and ionospheric effects on wave propagation; Multipath effects and fading; Ground waves and surface waves. Course will be offered every third semester.
Prereqs: ECE 3300 or Permission

ECE 4340 Antenna Principles and Design (3 credits)
Maxwell's equations, vector potential theory, radiation patterns, antenna efficiency and bandwidth, polarization, dipole and loop antennas, line sources, patch antennas, lineal arrays, antenna systems, radar equation.
Prereqs: ECE 3300 or Permission

ECE 4400 Digital Systems Engineering (3 credits)
Design of digital systems using a hardware description language and field-programmable gate arrays; projects emphasize a top-down design process using software tools; topics include datapath optimization, pipelining, static and dynamic memory, technology issues, intra-system communication, and design for testability.
Prereqs: ECE 2400, ECE 2410, or Permission

ECE 4410 Advanced Computer Architecture (3 credits)
Cross-listed with CS 4501
Joint-listed with CS 5501, ECE 5410
Principles and alternatives in instruction set design; processor implementation techniques, pipelining, parallel processors, memory hierarchy, and input/output; measurement of performance and cost/performance trade-off. Additional work required for graduate credit. Typically Offered: Fall.
Prereqs: CS 1550 and (STAT 3010 or STAT 2510) or Permission

ECE 4430 Distributed Processing and Control Networks (3 credits)
This course has three major parts: real-time computing, distributed processing, and control networks. Analysis of hardware and software performance with respect to speed, accuracy, and reliability. Investigation of ways of maximizing the three essential processor resources: memory, CPU time, and input/output. Methods for writing error free programs and designing fault tolerant computing systems.
Prereqs: ECE 3400, ECE 3410, ECE 3500, and ECE 3510

ECE 4440 Supervisory Control and Critical Infrastructure Systems (3 credits)
Cross-listed with CS 4440
Joint-listed with CS 5440, ECE 5440
Principles of network-based distributed real-time control and critical infrastructure systems. Integration of dedicated control protocols with wide area networks (e. g. the Internet). Issues of reliability, cost, and security. Application to selected industries, such as electric power distribution and waste and water management. Recommended preparation: ECE 3400, CS 2240, ME 3130, CE 3300, or CE 3720. Typically Offered: Spring.
Prereqs: Senior or Graduate standing in the College of Engineering

ECE 4442 IoT and CPS Security (3 credits)
Cross-listed with CYB 4442
Joint-listed with CYB 5442, ECE 5442
Internet of Things (IoT)/cyber-physical systems (CPS), and emerging applications of IoT/CPS systems. Covered topics and knowledge areas include systematic understanding of architecture and security analysis of the IoT/CPS systems; several network and data protocols; vulnerabilities and malware propagation and control in IoT/CPS systems; industrial control systems (ICS)/supervisory control and data acquisition (SCADA) security; IoT/CPS firmware analysis; zero trust model for IoT/CPS security; and medical IoT security. Additional assignments are required for graduate credit. Typically Offered: Spring.
Prereqs: CYB 3300

ECE 4450 Introduction to VLSI Design (3 credits)
Principles of design of very large scale integrated circuits; CMOS logic design; transistor sizing and layout methodologies; intro to IC CAD tools.
Prereqs: ECE 3100, ECE 2400 or Permission.

ECE 4500 Signals and Systems II (3 credits)
Continuation of ECE 3500. Two-sided Laplace transform. Relationships among Fourier series, Fourier transform, and Laplace transform. Feedback, modulation, filtering, sampling, state space analysis, and modeling of systems. Emphasis on practical applications of theory to solve engineering problems.
Prereqs: ECE 3500 and MATH 3300

ECE 4520 Communication Systems (3 credits)
Introduction to modern communication systems; baseband pulse and data communication systems; communication channels and signal impairments; filtering and waveform shaping in the time and frequency domain; carrier-modulation for AM and FM transmission; bandpass digital and analog communication systems; comparison of system performance. (Alt/years)
Prereqs: ECE 4500 and (STAT 3010 or MATH 4510) Cooperative: open to WSU degree-seeking students.

ECE 4550 Information and Coding Theory (3 credits)
Introduction to information theory; information content of messages; entropy and source coding; data compression; channel capacity data translation codes; fundamentals of error correcting codes; linear block and convolutional codes; introduction to trellis-coded modulation.
Prereqs: MATH 3300 and STAT 3010

ECE 4600 Semiconductor Devices (3 credits)
Introduction to semiconductor physics and basic semiconductor devices; intro to electro-optical devices.
Prereqs: ECE 3500

ECE 4620 Quantum Mechanics for Electrical Engineers (3 credits)
Joint-listed with ECE 5620
Fundamental theory and behavior of modern semiconductor devices. Additional projects/assignments required for graduate credit. Typically Offered: Spring.
Prereqs: ECE 4600 or Permission

ECE 4650 Introduction to Microelectronics Fabrication (3 credits)
Joint-listed with ECE 5650
This course serves as an introduction to the fabrication of microelectronic devices. Topics include the basics of IC structures, clean room protocol, photolithography, film growth and deposition, as well as IC interconnect technologies. Additional projects/assignments required for graduate credit.
Prereqs: ECE 3100

ECE 4690 Resilient Control of Critical Infrastructure (3 credits)
Joint-listed with ECE 5690
This course establishes a perspective on the unique challenges of automation in our society and provides insight on how an industrial control system works and how it can fail due to threats from cyber security, human error, and complex interdependencies. It also introduces concepts from the resilient controls community that attempt to make industrial control systems more resilient to these threats. Furthermore, it provides background to the vocabulary and fundamental concepts related to the variety of disciplines required for the effective management, control, and protection of critical infrastructure. Additional work required for graduate credit. Cooperative: open to WSU degree-seeking students.

ECE 4700 Control Systems (3 credits)
Cross-listed with ME 4810
Analysis and design of feedback control systems using frequency and time domain methods, and computer-aided design tools.
Prereqs: MATH 3300; Prereq for Electrical Engineering and Computer Engineering majors: ECE 3500 Prereq for Mechanical Engineering majors: ME 3130 Cooperative: open to WSU degree-seeking students.

ECE 4760 Digital Filtering (3 credits)
Design methods for recursive and non-recursive filters; frequency domain characteristics; computer-aided design; applications.
Prereqs: ECE 4500

ECE 4770 Digital Process Control (3 credits)
Cross-listed with CHE 4450
Dynamic simulation of industrial processes and design of digital control systems. Coordinated lecture-lab periods. Recommended Preparation: CHE 4440 (Recommended Preparation for EE majors: ECE 3500).

ECE 4800 EE Senior Design I (3 credits)
The capstone design sequence for electrical engineering majors. Course topics include design, research, simulation, and experimental methods; specifications, prototyping, troubleshooting and verification; report writing, documentation and oral presentations. Topics are considered in the context of a major design project involving a team of students. Projects incorporate realistic engineering constraints; i. e. environmental, sustainability, manufacturability, ethical, safety, social and political considerations.
Prereqs: ECE 2400, ECE 2410, ECE 3100, ECE 3110, ECE 3200, ECE 3210, ECE 3300, ECE 3310, ECE 3400, ECE 3410, ECE 3500, ECE 3510; or Permission
Coreqs: STAT 3010

ECE 4810 EE Senior Design II (3 credits)
General Education: Capstone Experience
The capstone design sequence for electrical engineering majors. Course topics include design, research, simulation, and experimental methods; specifications, prototyping, troubleshooting and verification; report writing, documentation and oral presentations. Topics are considered in the context of a major design project involving a team of students. Projects incorporate realistic engineering constraints; i. e. environmental, sustainability, manufacturability, ethical, safety, social and political considerations.
Prereqs: ECE 4800 and STAT 3010 or Permission

ECE 4820 Computer Engineering Senior Design I (3 credits)
The capstone design sequence for computer engineering majors. Application of formal software and hardware design techniques, hardware/software interface considerations, project management; specifications, prototyping, troubleshooting and verification; report writing, documentation and oral presentations. Topics are considered in the context of a major design project involving a team of students. Projects incorporate realistic engineering constraints; i. e. environmental, sustainability, manufacturability, ethical, safety, social and political considerations.
Prereqs: CS 2240, CS 2230, ECE 2400, ECE 2410, ECE 3100, ECE 3110, ECE 3400, ECE 3410, ECE 3500, and ECE 3510, or Permission
Coreqs: ECE 4400 and STAT 3010

ECE 4830 Computer Engineering Senior Design II (3 credits)
General Education: Capstone Experience
The capstone design sequence for computer engineering majors. Application of formal software and hardware design techniques, hardware/software interface considerations, project management; specifications, prototyping, troubleshooting and verification; report writing, documentation and oral presentations. Topics are considered in the context of a major design project involving a team of students. Projects incorporate realistic engineering constraints, i. e. , environmental, sustainability, manufacturability, ethical, safety, social and political considerations.
Prereqs: ECE 4400 and ECE 4820 and STAT 3010; or Permission

ECE 4870 Sustainable and Renewable Energy (3 credits)
Joint-listed with ECE 5870
This course will introduce technologies and characteristics for renewable and sustainable energy systems. Topics will include generation technologies, energy storage technologies and demand response concepts, including recent and future trends. Technological, economic, and policy issues for applying renewable energy technologies for grid connected and stand-alone uses will be presented. Additional projects/assignments required for graduate credit. Typically Offered: Fall.
Prereqs: Upper division standing in Electrical or Computer Engineering

ECE 4900 Near Space Engineering Leadership (1 credit, max 6)
This course is for students in the Near Space Engineering program who are in the position of flight director, assistant flight director, project systems engineer, launch and recovery manager, or leading one of the four flight engineering teams. The course emphasizes important leadership skills, including communication, planning and scheduling, and delegation. Students are expected to make oral technical presentations of goals, activities, progress, and accomplishments at technical meetings and conferences, work closely with research engineers and scientists in industry and NASA, and work with other high altitude scientific ballooning and near space engineering programs throughout the state. Recommended preparation: Prior experience and concurrent enrollment in University of Idaho Near Space Engineering Program.
Prereqs: Permission

ECE 4910 Senior Seminar (0 credits, max 99)
Technical topics, professional ethics, employment practice, and interviewing. One lecture per week. Graded Pass/Fail.

ECE 4980 (s) Internship (1-16 credits, max 99)
Credit arranged

ECE 4990 (s) Directed Study (1-16 credits, max 99)
Credit arranged

ECE 5000 Master's Research and Thesis (1-16 credits, max 99)
Credit arranged

ECE 5010 (s) Seminar (1-16 credits, max 99)
Credit arranged

ECE 5020 (s) Directed Study (1-16 credits, max 99)
Credit arranged

ECE 5030 (s) Workshop (1-16 credits, max 99)
Credit arranged

ECE 5040 (s) Special Topics (1-16 credits, max 99)
Credit arranged

ECE 5050 (s) Professional Development (1-16 credits, max 99)
Credit arranged

ECE 5150 Analog Integrated Circuit Design (3 credits)
Joint-listed with ECE 4150
Analog integrated circuit (IC) analysis, design, simulation, and layout, advanced biasing techniques, voltage references and regulators, operational amplifiers, frequency compensation techniques, noise analysis in analog circuits, and continuous-time integrated circuit filter design. Additional projects/assignments required for graduate credit. Cooperative: open to WSU degree-seeking students.

ECE 5160 Image Sensors and Systems (3 credits)
Joint-listed with ECE 4190
This course introduces various concepts and fundamentals related to semiconductor image sensors. Topics cover light production and detection, video image formats, image sensor characteristics and performance metrics, basic and advanced operation principals and types of semiconductor image sensors (CCD and CMOS), noise in imagers, image and color processing, and issues related to camera system design, integration and signal processing. Additional projects/assignments required for graduate credit. Cooperative: open to WSU degree-seeking students.

ECE 5180 Introduction to Electronic Packaging (3 credits)
Joint-listed with ECE 4180
This course serves as an introduction to electronic packaging and "back-end" microelectronic processes. Topics include substrate design & fabrication, SMT & first level assembly, clean room protocol, thermal design, simulation, and process considerations. Additional project work will be required for students enrolled in ECE 5180. Cooperative: open to WSU degree-seeking students.

ECE 5200 Advanced Electrical Machinery (3 credits)
Synchronous machines and transformers, machine transient and subtransient reactances, excitation and voltage regulation, power curves, transformer connections, impedance, harmonics, and impulse characteristics.
Prereqs: ECE 4220 Cooperative: open to WSU degree-seeking students.

ECE 5220 Induction Machines (3 credits)
Winding theory, reference frame theory, induction machine models, complex vector methods, small signal analysis, induction machine capability, simulation, introduction to variable speed drives.
Prereqs: ECE 3500, ECE 4220, or Permission Cooperative: open to WSU degree-seeking students.

ECE 5230 Symmetrical Components (3 credits)
Concepts of symmetrical components, sequence impedances of devices and lines, circuit equivalents for unbalanced faults, management during faults.
Prereqs: ECE 4220 Cooperative: open to WSU degree-seeking students.

ECE 5240 Transients in Power Systems (3 credits)
Analysis and simulation of electromagnetic transients on electric power systems; switching transients; lightning transients; mitigation of transient overvoltages; surge protection; modeling power systems apparatus for transient studies.
Prereqs: ECE 4210 Cooperative: open to WSU degree-seeking students.

ECE 5250 Power System Protection and Relaying (3 credits)
Power systems protection fundamentals; dynamic response of current voltage measurement devices; numerical relay fundamentals; review of symmetrical components; application of overcurrent elements, distance elements and differential elements for the real time protection and monitoring of transmission, distribution and generation apparatus.
Prereqs: ECE 4220 or Permission Cooperative: open to WSU degree-seeking students.

ECE 5260 Protection of Power Systems II (3 credits)
Protection of electrical equipment as related to electric power systems with emphasis on digital algorithms.
Prereqs: ECE 5250 or Permission Cooperative: open to WSU degree-seeking students.

ECE 5280 Understanding Power Quality (3 credits)
Electrical fundamentals in the context of power quality; origins and characterization of power quality problems on distribution systems; applications of standards; advanced ground techniques; case study approach to common situations.

ECE 5290 Utility Applications of Power Electronics (3 credits)
HVdc transmission, static VAr compensators, FACTS devices, Custom Power devices, electrical energy storage systems, power quality, harmonic compensation, and alternative energy supply interfacing.
Prereqs: ECE 4220

ECE 5300 Advanced Electromagnetic Theory I (3 credits)
Maxwell's equations, potential theory, wave propagation and scattering, canonical problems, guided wave theory, antenna concepts, boundary value problems.
Prereqs: ECE 4320 or Permission Cooperative: open to WSU degree-seeking students.

ECE 5310 Advanced Electromagnetic Theory II (3 credits)
Boundary value problems in non-Cartesian systems, diffraction, perturbation techniques, variational techniques, wave transformations.
Prereqs: ECE 5300 or Permission

ECE 5330 Antenna Theory (3 credits)
Maxwell's equations, reciprocity, equivalence theorems; wire antennas, antenna arrays, aperture antennas; analysis and design techniques; hardware considerations.
Prereqs: ECE 4320 or Permission Cooperative: open to WSU degree-seeking students.

ECE 5390 Advanced Topics in Electromagnetics (3 credits)
Topics include computational and analytical methods, remote sensing, nonlinear optics, guided wave theory, antenna theory. Typically Offered: Varies.
Prereqs: ECE 5300 or Permission

ECE 5410 Advanced Computer Architecture (3 credits)
Cross-listed with CS 5501
Joint-listed with CS 4501, ECE 4410
Principles and alternatives in instruction set design; processor implementation techniques, pipelining, parallel processors, memory hierarchy, and input/output; measurement of performance and cost/performance trade-off. Additional work required for graduate credit. Typically Offered: Fall.

ECE 5440 Supervisory Control and Critical Infrastructure Systems (3 credits)
Cross-listed with CS 5440
Joint-listed with CS 4440, ECE 4440
Principles of network-based distributed real-time control and critical infrastructure systems. Integration of dedicated control protocols with wide area networks (e. g. the Internet). Issues of reliability, cost, and security. Application to selected industries, such as electric power distribution and waste and water management. Recommended preparation: ECE 3400, CS 2240, ME 3130, CE 3300, or CE 3720. Typically Offered: Spring.

ECE 5442 IoT and CPS Security (3 credits)
Cross-listed with CYB 5442
Joint-listed with CYB 4442, ECE 4442
Internet of Things (IoT)/cyber-physical systems (CPS), and emerging applications of IoT/CPS systems. Covered topics and knowledge areas include systematic understanding of architecture and security analysis of the IoT/CPS systems; several network and data protocols; vulnerabilities and malware propagation and control in IoT/CPS systems; industrial control systems (ICS)/supervisory control and data acquisition (SCADA) security; IoT/CPS firmware analysis; zero trust model for IoT/CPS security; and medical IoT security. Additional assignments are required for graduate credit. Typically Offered: Spring.

ECE 5620 Quantum Mechanics for Electrical Engineers (3 credits)
Joint-listed with ECE 4620
Fundamental theory and behavior of modern semiconductor devices. Additional projects/assignments required for graduate credit. Typically Offered: Spring.

ECE 5650 Introduction to Microelectronics Fabrication (3 credits)
Joint-listed with ECE 4650
This course serves as an introduction to the fabrication of microelectronic devices. Topics include the basics of IC structures, clean room protocol, photolithography, film growth and deposition, as well as IC interconnect technologies. Additional projects/assignments required for graduate credit.

ECE 5690 Resilient Control of Critical Infrastructure (3 credits)
Joint-listed with ECE 4690
This course establishes a perspective on the unique challenges of automation in our society and provides insight on how an industrial control system works and how it can fail due to threats from cyber security, human error, and complex interdependencies. It also introduces concepts from the resilient controls community that attempt to make industrial control systems more resilient to these threats. Furthermore, it provides background to the vocabulary and fundamental concepts related to the variety of disciplines required for the effective management, control, and protection of critical infrastructure. Additional work required for graduate credit. Cooperative: open to WSU degree-seeking students.

ECE 5700 Random Signals (3 credits)
Probability, random variables, and random signals in engineering systems; stochastic calculus, stationarity, ergodicity, correlation, and power spectra; propagation of random signals through linear systems; Kalman filter theory and applications.
Prereqs: ECE 3500, and STAT 3010 or STAT 4510, or Permission Cooperative: open to WSU degree-seeking students.

ECE 5710 Estimation Theory for Signal Processing, Communications, and Control (3 credits)
Identification of dynamic system models from test data; methods to be considered include least-squares, prediction error, maximum likelihood, instrumental variables, correlation, and extended Kalman filter; practical applications and computer-based exercises emphasized within a mathematically rigorous framework. Typically Offered: Varies.
Prereqs: ECE 5700 or Permission

ECE 5720 Linear System Theory (3 credits)
Linear spaces and linear operators; descriptions of dynamic systems; input-output descriptions; state-space concepts; canonical forms; controllability and observability; minimal realizations; application to control and general systems analysis; pole assignment; observers.
Prereqs: ECE 4700 or equivalent Cooperative: open to WSU degree-seeking students.

ECE 5790 Engineering Acoustics (3 credits)
Cross-listed with ME 5130
Joint-listed with ME 4130
Fundamentals of acoustics including wave theory; transmission through layers, generation and reception; low frequency models; application to sound measurement, transducers, loudspeaker cabinet design, and nondestructive testing; acoustic design project required. Additional projects/assignments required for graduate credit.

ECE 5860 Industrial Control Systems (3 credits)
Cross-listed with NE 5860
Combines control systems theory and implementation topics. Theory topics include process dynamics and modeling; instrumentation, sensors and measurements; feedback and feedforward concepts; and basic control design methods. Implementation topics include programmable logic controllers, fundamentals of ladder logic, network configuration, and basic security concepts. Typically Offered: Fall.

ECE 5870 Sustainable and Renewable Energy (3 credits)
Joint-listed with ECE 4870
This course will introduce technologies and characteristics for renewable and sustainable energy systems. Topics will include generation technologies, energy storage technologies and demand response concepts, including recent and future trends. Technological, economic, and policy issues for applying renewable energy technologies for grid connected and stand-alone uses will be presented. Additional projects/assignments required for graduate credit. Typically Offered: Fall.

ECE 5880 Advanced Frequency-Domain Control (3 credits)
Advanced theory and design techniques for high-performance autonomous systems. Frequency-domain methods are presented, along with nonlinear dynamic compensation and absolute stability analysis. Emphasis placed on maximizing performance for reference tracking, disturbance rejection, and insensitivity to parameter variation. Suitable for graduate students and practicing control engineers. Applications include aerospace, power systems, electronics, and robotics problems. Typically Offered: Spring (Odd Years).
Prereqs: ECE 4700/ME 4810 or equivalent

ECE 5890 Power Systems Planning and Operation (3 credits)
Planning and operation of electric power systems. Topics include, but not limited to, economic dispatch, unit commitment, optimal power flow, and state estimation. Typically Offered: Fall (Odd Years).
Prereqs: ECE 4220

ECE 5910 Electrical Engineering Research Colloquium (0 credits, max 99)
Weekly colloquia on topics of general interest in electrical engineering and related fields; speakers will be from UI Electrical Engineering Department, other departments on campus, WSU, the local community, and outside agencies and universities. Graded Pass/Fail.

ECE 5980 (s) Cooperative Internship (1-16 credits, max 99)
Credit arranged. Supervised internship in industry in professional engineering settings, integrating academic study with work experience; requires a final written report and possible additional requirements to be worked out with the faculty supervisor. Graded Pass/Fail.

ECE 5990 (s) Non-thesis Master's Research (1-16 credits, max 99)
Credit arranged. Research not directly related to a thesis or dissertation.
Prereqs: Permission

ECE 6000 Doctoral Research and Dissertation (1-45 credits, max 99)
Credit arranged