# Electrical & Computer Engr (ECE)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 101</td>
<td>Foundations of Electrical and Computer Engineering</td>
<td>2</td>
<td>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. Coreq: MATH 143 or MATH 170.</td>
</tr>
<tr>
<td>ECE 204</td>
<td>(s) Special Topics</td>
<td>Credit arranged</td>
<td></td>
</tr>
<tr>
<td>ECE 210</td>
<td>Electrical Circuits I</td>
<td>3</td>
<td>Intro to d.c. and transient electrical circuits; mesh and nodal analysis; dependent sources; circuit theorems; transient analysis with differential equations. Three lec and one recitation a wk. Prereq: MATH 175 with a grade of 'C' or better Coreq: ECE 211, MATH 310 and PHYS 212 and PHYS 212L.</td>
</tr>
<tr>
<td>ECE 211</td>
<td>Electrical Circuits Lab I</td>
<td>1</td>
<td>Lab to accompany ECE 210. Lab experiments and computer simulations. One 3-hr lab a wk. Coreq: ECE 210 and PHYS 212 and PHYS 212L.</td>
</tr>
<tr>
<td>ECE 212</td>
<td>Electrical Circuits II</td>
<td>3</td>
<td>Continuation of ECE 210. Intro to sinusoidal steady state circuits; time and frequency domain analysis; Laplace transforms; Fourier series; transfer functions; Bode plots, filters. Three lec and one recitation a wk. Prereq: ECE 210, MATH 310, and PHYS 212 and PHYS 212L; a grade of 'C' or better is required for all prerequisite courses Coreq: ECE 213.</td>
</tr>
<tr>
<td>ECE 213</td>
<td>Electrical Circuits II Lab</td>
<td>1</td>
<td>Lab to accompany ECE 212. Continuation of ECE 211. Lab experiments and computer simulations. One 3-hr lab a wk. Prereq: ECE 211 and PHYS 212 and PHYS 212L. Coreq: ECE 212.</td>
</tr>
<tr>
<td>ECE 240</td>
<td>Digital Logic</td>
<td>3</td>
<td>Number systems, truth tables, logic gates, flip-flops, combinational and synchronous sequential circuits; intro to digital systems and basic microprocessor architecture. Prereq: PHYS 212 and PHYS 212L Coreq: ECE 241.</td>
</tr>
<tr>
<td>ECE 241</td>
<td>Logic Circuit Lab</td>
<td>1</td>
<td>Lab to accompany ECE 240. Prereq: PHYS 212 and PHYS 212L Coreq: ECE 240.</td>
</tr>
<tr>
<td>ECE 292</td>
<td>Sophomore Seminar</td>
<td>0</td>
<td>Curriculum options, elective courses, preparation for graduate study, professional ethics, and current technical topics. Field trip may be reqd. Graded P/F.</td>
</tr>
<tr>
<td>ECE 299</td>
<td>(s) Directed Study</td>
<td>Credit arranged</td>
<td></td>
</tr>
<tr>
<td>ECE 310</td>
<td>Microelectronics I</td>
<td>3</td>
<td>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. Prereq: ECE 212 and ECE 213 Coreq: ECE 311.</td>
</tr>
<tr>
<td>ECE 311</td>
<td>Microelectronics I Lab</td>
<td>1</td>
<td>Lab to accompany ECE 310. Coreq: ECE 310.</td>
</tr>
<tr>
<td>ECE 319</td>
<td>Background Study in Electronics</td>
<td>3</td>
<td>Not applicable toward any UI undergrad degree; valid only for removal of electronics (ECE 310) deficiency for grad students who do not have BSEE background. See ECE 310 for description. Graded P/F based on comprehensive exam at completion of course. Prereq: Permission.</td>
</tr>
<tr>
<td>ECE 321</td>
<td>Energy Systems I Laboratory</td>
<td>1</td>
<td>Lab to accompany ECE 320. Lab experiments and computer simulations. One 3-hr lab a wk. Prereq: ECE 213, PHYS 212, PHYS 212L, MATH 310 Coreq: ECE 320.</td>
</tr>
<tr>
<td>ECE 329</td>
<td>Background Study in Electrical Machines</td>
<td>3</td>
<td>Not applicable toward any UI undergrad degree; valid only for removal of electrical machinery (ECE 320) deficiency for grad students who do not have BSEE background. See ECE 320 for description. Graded P/F based on comprehensive exam at completion of course. Prereq: Permission.</td>
</tr>
<tr>
<td>ECE 330</td>
<td>Electromagnetic Theory</td>
<td>3</td>
<td>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. Prereq: MATH 275, MATH 310, and PHYS 212 and PHYS 212L Coreq: ECE 331.</td>
</tr>
<tr>
<td>ECE 331</td>
<td>Electromagnetics Laboratory</td>
<td>1</td>
<td>Lab to accompany ECE 330. Lab experiments and computer simulations. One 3-hr lab a wk. Prereq: MATH 275, MATH 310, PHYS 212 and PHYS 212L Coreq: ECE 330.</td>
</tr>
</tbody>
</table>
ECE 399 Background Study in Electromagnetic Theory
3 credits
Not applicable toward any UI undergrad degree; valid only for removal of electromagnetic theory (ECE 330) deficiency for grad students who do not have BSEE background. See ECE 330 for description. Graded P/F based on comprehensive exam at completion of course.
Prereq: Permission.

ECE 404 (s) Special Topics
Credit arranged.

ECE 410 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.
Prereq: ECE 310 and ECE 311; or Permission.

ECE 413 Radio-Frequency IC Design
3 credits
Joint-listed with ECE 513.
Radio frequency (RF) communications concepts, integrated circuit (IC) transceiver architectures, low-noise amplifier, mixers, passive devices and matching networks, oscillators, power amplifiers, phase-locked loops, and frequency synthesizers. Additional projects/assignments are required for graduate students. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 410 or Permission.

ECE 415 Analog Integrated Circuit Design
3 credits
Joint-listed with ECE 515.
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.
Prereq: ECE 410 or Permission.

ECE 417 Mixed Signal IC Design
3 credits
Joint-listed with ECE 517.
Sample and hold (S/H) circuits, comparators, data-converter fundamentals, Nyquist-rate digital-to-analog converters (DAC) and analog-to-digital converters (ADC), over-sampling data converters, and phase-locked loops. Additional projects/assignments are required for graduate credit. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 410 or Permission.

ECE 418 Introduction to Electronic Packaging
3 credits
Joint-listed with ECE 518.
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 518. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 310.

ECE 419 Image Sensors and Systems
3 credits
Joint-listed ECE 516.
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 are required for graduate credit. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 310.
ECE 420 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 420 cannot be counted as a graduate depth area course.
Prereq: ECE 320 and ECE 321.

ECE 421 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. (Fall only)
Coreq: ECE 420.

ECE 422 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. (Spring only)
Prereq: ECE 421.

ECE 427 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. Cooperative: open to WSU degree-seeking students.
Coreq: ECE 420.

ECE 430 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.
Prereq: ECE 330 or Permission.

ECE 432 Propagation of Wireless Signals
3 credits
Maxwell’s Equations, including Poynting’s vector and Poynting’s theorem; Wave equation with solutions, Helmholtz 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.
Prereq: ECE 330 or Permission.

ECE 434 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, linear arrays, antenna systems, radar equation.
Prereq: ECE 330 or Permission.

ECE 440 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.
Prereq: ECE 240, ECE 241, or Permission.

ECE 441 Advanced Computer Architecture
3 credits
Joint-listed with ECE 541. Cross-listed with CS 451, CS 551. 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.
Prereq: CS 150, STAT 301, ECE 240, or Permission.

ECE 443 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.
Prereq: ECE 340, ECE 341, ECE 350, and ECE 351.

ECE 444 Supervisory Control and Critical Infrastructure Systems
3 credits
Joint-listed with ECE 544. Cross-listed with CS 444, CS 544. 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 340, CS 240, ME 313, CE 330, or CE 372. (Spring, alt/yr.)
Prereq: Senior or Graduate standing in the College of Engineering.

ECE 445 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.
Prereq: ECE 310, ECE 240 or permission.

ECE 449 Fault-Tolerant Systems
3 credits
Joint-listed with CS 449. Cross-listed with ECE 449. Design, modeling, analysis and integration of hardware and software to achieve dependable computing systems employing on-line fault tolerance; theory and fundamental concepts of designing reliable systems; analytical evaluation techniques, faults and advances in ultra-reliable distributed systems, fault-tolerant software systems; case studies include the space Shuttle, Airbus, and Boeing fly-by-wire primary flight computers as well as systems in reliable data bases and financial markets. Additional projects and assignments reqd for grad cr.
Prereq: CS 240, ECE 441, or Permission.
ECE 450 Signals and Systems II
3 credits
Prereq: ECE 350 and MATH 330.

ECE 452 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. Cooperative: open to WSU degree-seeking students. (Alt/ yrs)
Prereq: ECE 450 and (STAT 301 or MATH 451)

ECE 455 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.
Prereq: MATH 330 and STAT 301.

ECE 460 Semiconductor Devices
3 credits
Introduction to semiconductor physics and basic semiconductor devices; intro to electro-optical devices.
Prereq: ECE 350.

ECE 462 Semiconductor Theory
3 credits
Joint-listed with ECE 562
Fundamental theory and behavior of modern semiconductor devices. Additional projects/assignments reqd for grad cr.
Prereq: ECE 460 or Permission.

ECE 465 Introduction to Microelectronics Fabrication
3 credits
Joint-listed with ECE 565
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.
Prereq: ECE 460 or Permission.

ECE 469 Resilient Control of Critical Infrastructure
3 credits
Joint-listed with ECE 569
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 470 Control Systems
3 credits
Cross-listed with ME 481
Analysis and design of feedback control systems using frequency and time domain methods, and computer-aided design tools. Cooperative: open to WSU degree-seeking students.
Prereq:MATH 330
Prereq for Electrical Engineering and Computer Engineering majors: ECE 350
Prereq for Mechanical Engineering majors: ME 313.

ECE 476 Digital Filtering
3 credits
Design methods for recursive and non-recursive filters; frequency domain characteristics; computer-aided design; applications.
Prereq: ECE 450.

ECE 477 Digital Process Control
3 credits
Cross-listed with CHE 445

ECE 480 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.
Prereq: ECE 240, ECE 241, ECE 310, ECE 311, ECE 320, ECE 321, ECE 330, ECE 331, ECE 340, ECE 341, ECE 350, ECE 351; or Permission Coreq: STAT 301.

ECE 481 EE Senior Design II
3 credits
Gen Ed: Senior 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.
Prereq: ECE 480 and STAT 301 or Permission.

ECE 482 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.
Prereq: CS 240, CS 270, ECE 240, ECE 241, ECE 310, ECE 311, ECE 340, ECE 341, ECE 350, and ECE 351, or Permission Coreq: ECE 440 and STAT 301.
ECE 483 Computer Engineering Senior Design II
3 credits
*Gen Ed: Senior 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.

**Prereq:** ECE 440 and ECE 482 and STAT 301; or Permission.

ECE 490 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.

**Prereq:** Permission.

ECE 491 Senior Seminar
0 credits

Technical topics, professional ethics, employment practice, and interviewing. One lecture a week. Graded P/F.

ECE 498 (s) Internship
Credit arranged.

ECE 499 (s) Directed Study
Credit arranged.

ECE 500 Master’s Research and Thesis
Credit arranged.

ECE 501 (s) Seminar
Credit arranged.

ECE 502 (s) Directed Study
Credit arranged.

ECE 503 (s) Workshop
Credit arranged.

ECE 504 (s) Special Topics
Credit arranged.

ECE 505 (s) Professional Development
Credit arranged.

ECE 513 Radio-Frequency IC Design
3 credits

Cooperative: open to WSU degree-seeking students.

Frequency synthesizers. Additional projects/assignments are required for graduate credit. Cooperative: open to WSU degree-seeking students.

**Prereq:** ECE 410 or Permission.

ECE 515 Analog Integrated Circuit Design
3 credits

Joint-listed with ECE 415

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.

**Prereq:** ECE 410 or Permission.

ECE 516 Image Sensors and Systems
3 credits

Joint-listed ECE 419

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 are required for graduate credit. Cooperative: open to WSU degree-seeking students.

**Prereq:** ECE 310.

ECE 517 Mixed Signal IC Design
3 credits

Joint-listed with ECE 517

Sample and hold (S/H) circuits, comparators, data-converter fundamentals, Nyquist-rate digital-to-analog converters (DAC) and analog-to-digital converters (ADC), over-sampling data converters, and phase-locked loops. Additional projects/assignments are required for graduate credit. Cooperative: open to WSU degree-seeking students.

**Prereq:** ECE 410 or Permission.

ECE 518 Introduction to Electronic Packaging
3 credits

Joint-listed with ECE 418

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 518. Cooperative: open to WSU degree-seeking students.

**Prereq:** ECE 310.

ECE 520 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. Cooperative: open to WSU degree-seeking students.

**Prereq:** ECE 422.

ECE 522 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. Cooperative: open to WSU degree-seeking students.

**Prereq:** ECE 350, ECE 422, or Permission.
ECE 523 Symmetrical Components
3 credits
Concepts of symmetrical components, sequence impedances of devices and lines, circuit equivalents for unbalanced faults, management during faults. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 422.

ECE 524 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. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 421.

ECE 525 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. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 524 or Permission.

ECE 526 Protection of Power Systems II
3 credits
Protection of electrical equipment as related to electric power systems with emphasis on digital algorithms. Cooperative: open to WSU degree-seeking students. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 524 or Permission.

ECE 527 Dynamics and Control of AC Drives
3 credits
Review of machine modeling techniques and simulation methods, principles of power converters for motor drive applications; analytical modeling and dynamic behavior of machine-drive systems; modulation, regulation, and control techniques; simulation of drive systems; case studies.
Prereq: ECE 320 and ECE 470, or Permission.

ECE 528 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.
Prereq: ECE 422.

ECE 529 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.
Prereq: ECE 422.

ECE 530 Advanced Electromagnetic Theory I
3 credits
Prereq: ECE 432 or Permission.

ECE 531 Advanced Electromagnetic Theory II
3 credits
Boundary value problems in non-Cartesian systems, diffraction, perturbation techniques, variational techniques, wave transformations.
Prereq: ECE 530 or Permission.

ECE 533 Antenna Theory
3 credits
Maxwell's equations, reciprocity, equivalence theorems; wire antennas, antenna arrays, aperture antennas; analysis and design techniques; hardware considerations. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 432 or Permission.

ECE 541 Advanced Computer Architecture
3 credits
Joint-listed with ECE 441. Cross-listed with CS 451, CS 551.
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.
Prereq: CS 150, STAT 301, ECE 240, or Permission.

ECE 544 Supervisory Control and Critical Infrastructure Systems
3 credits
Joint-listed with ECE 444. Cross-listed with CS 444, CS 544.
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 340, CS 240, ME 313, CE 330, or CE 372. (Spring, alt/yr.)
Prereq: Senior or Graduate standing in the College of Engineering.

ECE 555 Information Theory
3 credits
Introduction to Shannon Theory; entropy, relative entropy, and mutual information; asymptotic equipartition; entropy rates of stochastic processes; data compression; channel capacity, differential entropy; the Gaussian channel, Lempel-Ziv coding, rate distortion theory.
Prereq: ECE 455 or Permission.

ECE 562 Semiconductor Theory
3 credits
Joint-listed with ECE 462.
Fundamental theory and behavior of modern semiconductor devices. Additional projects/assignments reqd for grad cr.
Prereq: ECE 460 or Permission.

ECE 565 Introduction to Microelectronics Fabrication
3 credits
Joint-listed with ECE 465.
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.
Prereq: ECE 310.
ECE 569 Resilient Control of Critical Infrastructure
3 credits
Joint-listed with ECE 469
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 570 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. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 350, and STAT 301 or STAT 451, or Permission.

ECE 572 Linear System Theory
3 credits
Cross-listed with ME 580.
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. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 470 or Equivalent.

ECE 574 Optimal Control Theory
3 credits
Intro to optimization, parameter optimization, optimization of dynamic systems, optimization of dynamic systems with path constraints, optimal feedback control and dynamic programming, linear quadratic regulators, second variation methods, singular control problems, differential games. Cooperative: open to WSU degree-seeking students.
Prereq: ECE 572 or Permission.

ECE 591 Electrical Engineering Research Colloquium
0 credits
Graded P/F. 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.

ECE 598 (s) Cooperative Internship
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 P/F.
Prereq: Permission.

ECE 599 (s) Non-thesis Master's Research
Credit arranged
Research not directly related to a thesis or dissertation.
Prereq: Permission.

ECE 600 Doctoral Research and Dissertation
Credit arranged.