ELECTRICAL & COMPUTER ENGINEERING

Courses

ECE 100. Introduction to Electrical & Computer Engineering. 0 Hours
Introduction to electrical and computer engineering faculty, facilities, and curriculum. Career opportunities in electrical and computer engineering and areas of specialization are discussed.

ECE 101. Introduction to Electrical & Computer Engineering II. 0 Hours
Introduction to electrical and computer engineering faculty, facilities, and curriculum. Career opportunities in electrical and computer engineering and areas of specialization are discussed. Second semester seminar.

ECE 198. Multidisciplinary Research & Innovation Laboratory. 1-6 Hours
Students participate in 1.) selection and design, 2.) investigation and data collection, 3.) analysis, and 4.) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

ECE 200. Professional Development Seminar. 0 Hours
Presentations on contemporary and professional engineering subjects by students, faculty, and engineers in active practice. The seminar addresses topics in key areas that complement traditional courses and prepare distinctive graduates, ready for life and work. Registration required for all sophomore students.

ECE 201. Circuit Analysis. 3 Hours
Principles of linear circuit analysis and problem solving techniques associated with circuits containing both passive and active components. Includes analysis of linear circuits with direct current (DC) and alternating current (AC) excitation, as well as a study of transient behavior. Course includes an additional mandatory supervised weekly problem session. Prerequisite(s): MTH 168. Corequisite(s): ECE 211.

ECE 201L. Circuit Analysis Laboratory. 1 Hour
Laboratory course stressing experimental techniques, laboratory reporting, safety, and instrumentation. Experimental investigation of linear circuit component behavior and the DC, AC, and transient response of linear circuits. Corequisite(s): ECE 201 or EGR 203.

ECE 203. Introduction to MATLAB Programming. 1 Hour
MATLAB system and development environment, vector and matrix operations using MATLAB, linear algebra and calculus using MATLAB, MATLAB graphics, flow control, symbolic math toolbox. Prerequisite(s): (CPS 132 or CPS 150) or equivalent.

ECE 204. Electronic Devices. 3 Hours
Study of the terminal characteristics of electronic devices and basic single stage amplifier configurations using bipolar junction transistors and field-effect transistors. Analysis of the devices includes a qualitative physical description, volt-ampere curves, and the development of small- and large-signal equivalent circuit models. Prerequisite(s): EGR 203 or ECE 201. Corequisite(s): ECE 204L.

ECE 204L. Electronic Devices Laboratory. 1 Hour
Laboratory investigation of electronic devices: diodes, bipolar junction transistors, field-effect transistors and operational amplifiers. Corequisite(s): ECE 204.

ECE 215. Introduction to Digital Systems. 3 Hours
Introduction to binary systems, logic circuits, Boolean algebra, simplification methods, combinational circuits and networks, programmable logic devices, flip flops, registers, counters, memory elements, and analysis and design of sequential circuits. Prerequisite(s): EGR 203 or ECE 201. Corequisite(s): ECE 215L.

ECE 215L. Digital Systems Laboratory. 1 Hour
Laboratory investigation of digital logic circuits and systems covered in ECE 215. Logic gate characteristics; combinational logic design and analysis; latches and flip-flops; synchronous and asynchronous sequential logic; simple digital systems. Experiments include design and analysis of digital systems using breadboarding, FPGA boards, modeling and simulation tools, hardware description languages, and logic synthesis tools. Prerequisite(s): ECE 201, ECE 201L. Corequisite(s): ECE 215.

ECE 298. Multidisciplinary Research & Innovation Laboratory. 1-6 Hours
Students participate in 1.) selection and design, 2.) investigation and data collection, 3.) analysis, and 4.) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

ECE 300. Professional Development Seminar II. 0 Hours
Junior level professional development seminar. Presentations on contemporary and professional engineering subjects by students, faculty, and engineers in active practice. The seminar addresses topics in key areas that complement traditional courses and prepare distinctive graduates, ready for life and work. Registration required for all junior ECE students. Prerequisite(s): ECE 200 or COP 200.

ECE 303. Signals & Systems. 3 Hours
Mathematical framework associated with the analysis of linear systems including signal representation by orthogonal functions, convolution, Fourier and Laplace analysis, and frequency response of circuits and systems. Prerequisite(s): ECE 204; MTH 219. Corequisite(s): ECE 303L.

ECE 303L. Signals & Systems Laboratory. 1 Hour
Laboratory investigation of signals and systems including signal decomposition, system impulse response, convolution, frequency analysis of systems, and filter design and realization. Prerequisite(s): ECE 204. Corequisite(s): ECE 303.

ECE 304. Electronic Systems. 3 Hours
ELECTRONIC SYSTEMS Study of cascaded amplifiers, feedback amplifiers, linear integrated circuits, and oscillators including steady state analysis and analysis of frequency response. Prerequisite(s): ECE 303. Corequisite(s): ECE 304L.

ECE 304L. Electronic Systems Laboratory. 1 Hour
Design, construction and verification of multistage amplifiers, differential amplifiers, feedback amplifiers, passive and active filters, and oscillators. Prerequisite(s): ECE 303. Corequisite(s): ECE 304.

ECE 314. Fundamentals of Computer Architecture. 3 Hours
Study of computer systems organization, representation of data and instructions, instruction set architecture, processor and control units, memory devices and hierarchy, I/O devices and interfacing peripherals, high- to low-level language mapping, system simulation and implementation, applications and practical problems. Prerequisite(s): CPS 150; ECE 215. Corequisite(s): ECE 314L.
ECE 314. Fundamentals of Computer Architecture Laboratory. 1 Hour
Laboratory investigation of digital computer architecture covered in ECE 314. Computer sub-systems such as central processing units, control units, I/O units, and hardware/software interfaces will be experimentally considered. Simulation and implementation will be used to study applications and practical problems. Prerequisite(s): ECE 215. Corequisite(s): ECE 314.

ECE 316. Introduction to Electrical Energy Systems. 3 Hours
A broad introduction to electric energy concepts. Generation, transmission, distribution, and utilization of electric energy. Renewable energy, three phase systems, transformers, power electronics, motors and generators. Contemporary topics. Prerequisite(s): ECE 203 or equivalent.

ECE 322. Electromagnetics. 3 Hours
Study of vector calculus, electro- and magneto-statics, Maxwell's equations, and electromagnetic plane waves and their reflection and transmission from discontinuities. Prerequisite(s): PHY 232.

ECE 332. Applied Electromagnetics. 3 Hours
Electromagnetic theory applied to problems in the areas of waveguides, radiation, electro-optics and electromagnetic interference and electromagnetic compatibility. Prerequisite(s): ECE 332.

ECE 334. Discrete Signals & Systems. 3 Hours
Introduction to discrete signals and systems including sampling and reconstruction of continuous signals, digital filters, frequency analysis, the z-transform, and the discrete Fourier transform. Prerequisite(s): ECE 303.

ECE 340. Engineering Probability & Random Processes. 3 Hours
Axiomatic probability, derived probability relationships, conditional probability, statistical independence, total probability and Bayes' Theorem, counting techniques, common random variables and their distribution functions, transformations of random variables, moments, autocorrelation, power spectral density, cross correlation and covariance, random processes through linear and nonlinear systems, linear regression, and engineering decision strategies. Prerequisite(s): ECE 303; MTH 218.

ECE 398. Multidisciplinary Research & Innovation Laboratory. 1-6 Hours
Students participate in 1.) selection and design, 2.) investigation and data collection, 3.) analysis, and 4.) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

ECE 401. Communication Systems. 3 Hours
Study of amplitude, angle, pulse, and digital communication systems including generation, detection, and analysis of modulated signals and power, bandwidth, and noise considerations. Prerequisite(s): ECE 304, 340. Corequisite(s): ECE 401L.

ECE 401L. Communication Systems Laboratory. 1 Hour
Design, fabrication, and laboratory investigation of modulators, detectors, filters, and associated communication components and systems. Prerequisite(s): ECE 304. Corequisite(s): ECE 401.

ECE 414. Electromechanical Devices. 3 Hours
Introduction to electromechanical devices: nonlinear electromagnetic actuators, rotating machine analysis, field and circuit concepts and direct current, synchronous, and induction machines, special-purpose machines and fractional horsepower machines. Prerequisite(s): ECE 316 or equivalent.

ECE 415. Control Systems. 3 Hours
Study of mathematical models for control systems and analysis of performance characteristics and stability. Design topics include pole-placement, root locus, and frequency domain techniques. Prerequisite(s): ECE 303.

ECE 416. Introduction to Industrial Robotic Manipulators. 3 Hours
Topics include homogeneous transformations, direct and inverse kinematics, trajectory generation, and selected topics of robot vision. Prerequisite(s): ECE 303.

ECE 431L. Multidisciplinary Design I. 2 Hours
Application of engineering fundamentals to sponsored multidisciplinary-team design projects. In a combination of lecture and lab experiences, students learn the product realization process and project management. Product realization topics include idea generation, proposal development, design specifications, conceptualization and decision analysis. Project management topics include cost estimation and intellectual property management. Design projects progress to the proof of concept and prototype development stages. Prerequisite(s): MEE students: EGM 303, MEE 321, and MEE 344 ECE students: ECE 304 and ECE 314.

ECE 432L. Multidisciplinary Design II. 3 Hours
One hour lecture and five hours of lab per week. Detailed evaluation of the Product Realization Process focusing on conceptual design, embodiment design, final design and prototyping is taught. Analysis of the design criteria for safety, ergonomics, environment, cost and sociological impact is covered. Periodic oral and written status reports are required. The course culminates in a comprehensive written report and oral presentation. Prerequisite(s): MEE majors: MEE 431L; CPE majors: ECE431L and (ECE334 or ECE340 or CPS356) and (ECE444 or CPS 444). ELE majors: ECE 431L and (ECE 333 or ECE 334 or ECE 340) and (ECE 401 or ECE 415).

ECE 433. Project Management & Innovation. 1 Hour
Introduces students and teams to project management, entrepreneurship, and innovation. Topics include project management, cost estimating, time value of money, patent law, marketing, finance, and business plan development. Prerequisite(s): Junior status.

ECE 440. Physical Electronics. 3 Hours
Introduction to wave mechanics, electron ballistics, theory of metals and semiconductors, electron emission, space charge flow, and modern electronic devices. Prerequisite(s): MTH 219, PHY 232.

ECE 441. Integrated Circuit Electronics. 3 Hours
Integrated circuit design, construction and verification including the study of biasing, multistage differential and analog power amplification, and computer assisted design tools for "on-chip" design and layout. Prerequisite(s): ECE 304.

ECE 442. Engineering Electromagnetics. 3 Hours
Processing Maxwell's equations and applying the predictions to the analysis and design of engineering systems that make use of electromagnetic energy from ELF through optical frequencies. Topics include propagation, radiation, interactions with matter, guided waves, and antenna fundamentals. Prerequisite(s): ECE 333.

ECE 443. Introduction to Electro-Optics. 3 Hours
Introductory overview of electro-optics starting with Maxwell's equations and leading to lasers, holography, and other timely applications. Prerequisite(s): ECE 332.
ECE 444. Advanced Digital Design. 3 Hours
Systems approach to digital design including: structured top-down development process using simple and complex logic modules from various logic families; practical aspects of the design, construction, and verification of digital subsystems; application of microcomputer and/or controller as a flexible logic device; real-time embedded systems design; and the use of HDL tools and simulation. Prerequisite(s): ECE 314.

ECE 445. Signal Processing. 3 Hours
Selected topics in digital signal and image processing with design projects. The design projects are determined by the instructor and may come from a variety of signal processing applications including medical image processing, video processing, computer vision, statistical signal processing, speech processing, radar signal processing, etc. Prerequisite(s): ECE 334.

ECE 446. Microelectronic Systems Design. 3 Hours
Basic integrated circuit design concepts, system layout, application of design methodology, the fabrication process, manufacturing limitations of the design process, and CAD/CAE utilization to realize the design process. Prerequisite(s): ECE 304.

ECE 447. Digital Control Systems. 3 Hours
Analysis and synthesis of feedback control systems including digital compensators. Topics include performance and stability analysis, regulator and servomechanism design using time and frequency domain methods, and digital implementation case studies. Prerequisite(s): ECE 415; ECE 334 or equivalent.

ECE 448. Fiber Optic Communications. 3 Hours
General light guidance principles; ray optics; dispersion; single mode, multimode, and graded index fibers; basic laser and LED source principles; photodetectors; error probability in digital optical systems; rise time analysis; loss budget analysis; local area networks and long haul communication links. Prerequisite(s): ECE 333 Corequisite(s): ECE 401.

ECE 449. Computer Systems Engineering. 3 Hours
An introduction to advanced computer architecture and computer systems design. Topics include: exploration of principle architecture features of modern computers, pipelining, memory hierarchy, I/O devices, interconnection networks, introduction to parallel and multiprocessor systems, and the use of hardware description languages (HDLs) in system implementation. Prerequisite(s): ECE 444, (CPS 346 or permission of instructor).

ECE 450L. Projects Laboratory. 1-3 Hours
Project-oriented laboratory applying engineering skills in the design, development, and demonstration of electrical and electronic systems. Prerequisite(s): Permission of project advisor.

ECE 471. Contemporary Power Systems & the Smart Grid. 3 Hours
Introduction to electrical power systems; generation, transmission and utilization; power system analysis; power system control; energy management; and an introduction to smart grid technologies. Prerequisite(s): ECE 316 or equivalent.

ECE 472. Smart Grid Technologies. 3 Hours
An introductory study of enabling technologies and energy issues necessary for full realization of the Smart Grid. Course topics vary. This course can be taken multiple times. Prerequisite(s): ECE 471 or equivalent.

ECE 493. Honors Thesis. 3 Hours
Selection, design, investigation, and completion of an independent, original research study resulting in a document prepared for submission as a potential publication and a completed undergraduate thesis. Restricted to students in University Honors Program.

ECE 494. Honors Thesis. 3 Hours
Selection, design, investigation, and completion of an independent, original research study resulting in a document prepared for submission as a potential publication and a completed undergraduate thesis. Restricted to students in University Honors Program. Prerequisite(s): ECE 493.

ECE 498. Multidisciplinary Research & Innovation Laboratory. 1-6 Hours
Students participate in 1.) selection and design, 2.) investigation and data collection, 3.) analysis, and 4.) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

ECE 499. Special Problems in Electrical & Computer Engineering. 1-6 Hours
Particular assignments to be arranged and approved by the department chairperson.

ECE 500. Introduction to the Graduate Program in Electrical and Computer Engineering. 0 Hours
Introduction to ECE graduate program, research methods in ECE, technical writing, literature research, ethics, software and resources.

ECE 501. Contemporary Digital Systems. 3 Hours
Introduction to sequential logic; state machines; high-performance digital systems: theory and application of modern design, alternative implementation forms and introduction to HDL; productivity, recurring and non-recurring costs, flexibility, and testability; software drivers; hardware/software integration; finite state machines. Required background: ECE 215 or equivalent.

ECE 503. Random Processes. 3 Hours
Random variables as applied to system theory, communications, signal processing and controls. Topics include advanced engineering probability, random variables, random vectors and an introduction to random processes. Required background: ECE 340 or equivalent.

ECE 505. Digital Signal Processing. 3 Hours
A study of one-dimensional digital signal processing, including a review of continuous system analysis and sampling. Topics include z-transform techniques, digital filter design and analysis, and fast Fourier transform processing techniques. Required background: ECE 334 or equivalent course.

ECE 506. Microelectronic Devices. 3 Hours
Crystalline structure of matter, quantum mechanics and energy band theory; bulk properties of semiconductors; p-n and metal-semiconductor junctions; bipolar junction transistors; field-effect transistors; heterostructures; optical properties of semiconductors; devices, modeling and applications. Required background: ECE 304 or equivalent.

ECE 507. Electromagnetic Fields I. 3 Hours
Fundamental concepts, wave equation and its solutions; wave propagation, reflection and transmission; potential theory; construction of modal solutions; various electromagnetic theorems: concept of source, uniqueness, equivalence, induction and reciprocity theorems. Required background: ECE 333 or equivalent.

ECE 509. Analysis of Linear Systems. 3 Hours
State variable representation of linear systems and its relationship to the frequency domain representation using transfer functions and the Laplace transform. State transition matrix and solution of the state equation, stability, controllability, observability, state feedback and state observers are studied.

ECE 510. Microwave Circuits for Communications. 3 Hours
Microwave transmission, planar transmission lines, microwave components and filters. Microwave tubes, microwave communication, radar systems, and electronic support measures. Prerequisite(s): ECE 507.
ECE 511. Antennas. 3 Hours
Fundamental principles of antennas; analysis and synthesis of arrays; resonant antennas; broadband and frequency independent antennas; aperture and reflector antennas; applications to radar and communication systems. Prerequisite(s): ECE 507 or equivalent.

ECE 515. Engineering Magnetic Materials & Their Function in Green Energy. 3 Hours
Magnetic fundamentals including spontaneous magnetization; advanced magnetic materials; computer modeling of magnetic circuits using 2D/3D finite element analysis. Applications of magnetic materials in electric machines. Prerequisite(s): MAT 501; college physics or permission of instructor.

ECE 521. Digital Communications I. 3 Hours
Fundamentals of digital transmission of information over noisy channels; modulation schemes for binary and M-ary digital transmission; optimum receivers; coherent and noncoherent detection; signal design; intersymbol interference; error control coding; the Viberti algorithm; channel capacity and Shannon limits on reliable transmission.

ECE 522. Satellite Communications. 3 Hours
Topics related to the theory, design and orbital placement of geostationary and geosynchronous satellites and their communications applications, including transmitters and receivers in the RF, microwave and optical operational windows, the associated modulation and communication strategies, system hardware and international satellite networks.

ECE 530. Digital Integrated Circuit Design. 3 Hours
Integrated circuit design and layout concepts, design methodology, fabrication process and limitations, MOSFET models for digital design, inverter and logic gates, interconnect and delay, combinational circuits, sequential circuits, datapath subsystems, memory circuits, digital phase lock loops. Required background ECE 304.

ECE 531. Analog Integrated Circuit Design. 3 Hours
Integrated circuit design concepts and layout; system perspective on analog design; MOS device theory and processing technology; current mirrors and biasing circuits; voltage and current references; single-stage, differential and operational amplifiers; CAD utilization to realize the design process. Required background ECE 304 or equivalent.

ECE 532. Embedded Systems. 3 Hours
This course will introduce the student to the concept of embedded systems and the constraints imposed on hard real-time systems. Course will consist of design, development and test of selected hard-deadline hardware and software using Altera’s DE2 development boards. The student will design selected hardware interfaces and develop real-time executive and application code in assembly language and C. Each student will design and implement hardware using Verilog HDL. Prerequisite(s): ECE 501 or equivalent.

ECE 533. Computer Design. 3 Hours
Design considerations of the computer; register transfer operations; hardware implementation of arithmetic processors and ALU; instruction set format and design and its effect on the internal microengine; hardware and microprogrammed control design; comparative architectures. Required background: ECE 501 or equivalent.

ECE 536. Microprocessor Applications. 3 Hours
Project studies, applications of microprocessors in practical implementations; logic implementation using software; memory mapped I/O problems and interrupt structure implementation; use of compilers; study of alternate microprocessor families including industrial controllers. Required background: ECE 314 or equivalent.

ECE 538. Object-Oriented Programming Applications. 3 Hours
A semi-formal approach to the engineering applications of object-oriented programming. Application of the concepts of classes, inheritance, polymorphism in engineering problems. Introduction to the use of class libraries. Effective integration of the concepts of application programmer interfaces, language features and class libraries. Required background is C programming experience.

ECE 545. Automatic Control. 3 Hours
Study of mathematical methods for control systems and analysis of performance characteristics and stability. Design topics include pole-placement, root locus, and frequency domain techniques. The student will also learn feedback loop sensitivity, basic loopshaping, performance bounds and other introductory aspects of robust control. Required background is ECE 415 or equivalent.

ECE 547. Non-Linear Systems & Control. 3 Hours
Introduction to nonlinear phenomena in dynamical systems. A study of the major techniques of nonlinear system analysis including phase plane analysis and Lyapunov stability theory. Application of the analytical techniques to control system design including feedback linearization, backstepping and sliding mode control. Prerequisite(s): ECE 509 or permission of instructor.

ECE 556. 3D Computer Vision. 3 Hours
Develop the skills needed to generate synthetic images of 3D objects and to recover 3D structure from one or more views (projections) of 3D objects. Feature recognition in 2D views (images) of a scene based either on actual photographs or synthetic images (computer graphics generated). Applications in robot pose recognition and mobile robot navigation. However, accommodations will be made for students with experience in only one of these areas. Prerequisite(s): ECE 538, ECE 563, or permission of instructor.

ECE 564. Machine Learning & Patterning. 3 Hours
This course introduces the fundamental concepts and models of machine learning with a practical treatment of design, analysis, implementation and applications of algorithms that learn from examples. Topics include supervised and unsupervised learning, self organization, pattern association, feed-forward and recurrent architectures, manifold learning, dimensionality reduction, and model selection. Required background: ECE 445 or equivalent.

ECE 565. Linear Systems & Fourier Optics. 3 Hours
Mathematical techniques pertaining to linear systems theory; Fresnel and Fraunhofer diffraction; Fourier transform properties of lenses; frequency analysis of optical systems, spatial filtering, applications such as optical information processing and holography. Prerequisite(s): Acceptance into the ECE graduate program or permission of the department chairperson.

ECE 567. Electro-Optical Devices & Systems. 3 Hours
Solid-state theory of optoelectronic devices; photoemitters; photodetectors; solar cells; detection and noise; displays; electro-optic, magneto-optic, and acousto-optic modulators; integration and application of electro-optical components in electro-optical systems of various types. Prerequisite(s): ECE 507 or permission of department chairperson.

ECE 574. Guided Wave Optics. 3 Hours
Light propagation in slab and cylindrical waveguides; signal degradation in optical fibers; optical sources, detectors, and receivers; coupling; transmission link analysis; fiber fabrication; fiber sensor and communication systems. Prerequisite(s): ECE 507 or permission of department chairperson.
ECE 576. Introduction to Radar. 3 Hours
Introduction to the radar range equation, fields and Waves, antennas and phased arrays, beamforming, targets and clutter radar cross section, fast time, slow time, detection processing, tracking, space-time adaptive processing, FMCW radar, SAR and ISAR, electronic warfare, transmitters, receivers and signal processors. Required background: ECE303, ECE332, ECE340, or equivalent.

ECE 577L. Electro-Optics Laboratory. 1 Hour
Fiber optic principles and systems: numerical aperture, loss, dispersion, single and multimode fibers, communications and sensing systems; project oriented investigations of Electro/fiber-optic systems and devices in general, sources, detectors, image processing, sensor instrumentation and integration, Electro-optic components, display technology, and nonlinear optical devices and systems. Prerequisite(s): ECE 574 or permission of department chairperson.

ECE 580. Principles of Nanofabrication. 3 Hours
Basic principles of processes used in microelectronic and photonic device fabrication: vacuum systems, plasma processes, physical and chemical vapor deposition, properties of silicon and other substrate materials, photolithography and non-optical lithography, wet chemical and plasma etching, thermal oxidation of silicon, semiconductor doping, ion implantation, metallization, electrical contacts and micro-metrology.

ECE 581. Nanoelectronics. 3 Hours
Introduction to the physics of materials on the nanoscale; quantum confinement theory; electronic and optical properties of semiconductor nanostructures; single electron transistors (SETs); tunneling and ballistic devices; nanostructured LEDs, photodetectors, and lasers; nanophotovoltaics and nanomagnetics; quantum computing and molecular electronics; nanoelectronic fabrication, state-of-the-art and emerging nanoscale devices and applications. Prerequisite(s): ECE 506 or permission of instructor.

ECE 583. Advanced Photovoltaics. 3 Hours
Science and applications of photovoltaics, with special emphasis on inorganic and organic semiconductors, ferroelectrics, chalcopyrites, metamaterials, quantum structures and photovoltaics architecture. Prerequisite(s): ECE 506 or permission of instructor.

ECE 595. Special Problems in Electrical Engineering. 1-6 Hours
Particular assignments to be arranged and approved by the department chair.

ECE 599. Thesis. 1-6 Hours
Thesis in Electrical and Computer Engineering.

ECE 633. Advanced Computer Architecture. 3 Hours
Examination of modern high performance computing architectures, including out-of-order execution RISC multicore processors and GPGPUs. Design projects integrate the concepts learned in class. Prerequisite(s): ECE 533.

ECE 642. Optimal Control & Estimation. 3 Hours
Introduction to optimal control, starting with dynamic programming for stochastic optimal control; continuous time optimal control, including Pontryagin’s Maximum Principle and its application to the linear case, leading to linear optimal control. Prerequisite(s): ECE 509 or permission of instruction.

ECE 645. Adaptive Control. 3 Hours
On-line approximation based adaptive control techniques for nonlinear systems. An introduction to neural networks and fuzzy systems as part of the control loop is given, leading to a diversity of advanced methods for controlling and stabilizing nonlinear systems subject to uncertainties. Adaptive observers and adaptive output feedback are also introduced. Prerequisite(s): ECE 547 or permission of instructor.

ECE 661. Statistical Signal Processing. 3 Hours
This course studies discrete methods of linear estimation theory. Topics include random vectors, linear transformations, linear estimation theory, optimal filtering, least squares techniques, linear prediction, and spectrum estimation. Prerequisite(s): ECE 503, ECE 505.

ECE 662. Adaptive Signal Processing. 3 Hours
An overview of the theory, design, and implementation of adaptive signal processors. This includes discussions of various gradient search techniques, filter structures, and applications. An introduction to neural networks is also included. Prerequisite(s): ECE 661.

ECE 663. Statistical Pattern Recognition. 3 Hours
This course provides a comprehensive treatment of the statistical pattern recognition problem. The mathematical models describing these problems and the mathematical tools necessary for solving them are covered in detail. Prerequisite(s): ECE 661.

ECE 674. Integrated Optics. 3 Hours
Asymmetric dielectric slab wave-guides; cylindrical wave-guides; multi-layer wave-guides; dispersion, shifting and flattening; mode coupling and loss mechanisms; selected nonlinear wave-guiding effects; integrated optical devices. Prerequisite(s): ECE 574.

ECE 675. Quantum Electronics. 3 Hours
Principles of the quantum theory of electron and photon processes; interaction of electromagnetic radiation and matter; applications to solid state and semiconductor laser systems. Prerequisite(s): ECE 506, or EOP 506/ ECE 573 or equivalent.

ECE 676. Quantum Electronics. 3 Hours
Principles of the quantum theory of electron and photon processes; interaction of electromagnetic radiation and matter; applications to solid state and semiconductor laser systems. Prerequisite(s): ECE 506, or EOP 506/ ECE 573 or equivalent.

ECE 682. Nano-Fabrication Laboratory. 3 Hours
This laboratory course will provide hands-on experience in state-of-the-art device fabrication technology. The course will be conducted primarily in a clean room laboratory with some classroom sessions for discussions. The students will have an opportunity to design, fabricate and test their own devices. Prerequisite(s): Permission of instructor.

ECE 695. Special Problems in Electrical and Computer Engineering. 1-6 Hours
Special topics in electrical engineering not covered in regular courses. Course sections arranged and approved by the chair of the student’s doctoral advisory committee and the department chair.

ECE 696. Graduate Seminar. 0-3 Hours
Research oriented independent study course intended for doctoral level graduate students. The student will perform an in-depth research on a selected topic of mutual interest with his/her doctoral adviser, and achieve sufficient expertise to do a technical presentation about the topic in front of his/her peers. The student will prepare a report and present it in one of the graduate seminar sessions during the semester. The student is expected to attend all the seminars presented by other graduate students during the semester and to interact with them to improve the depth and breadth of his/her knowledge.

ECE 699. PhD Dissertation. 1-15 Hours
Original research in electrical engineering that makes a definite contribution to technical knowledge. Results must be of sufficient importance to merit publication in a refereed journal.