Fall 2022 Course Descriptions as of 03/29/2022 08:13 PM

Information in Browse Course Catalog is subject to change. Information is term specific. Please refer to the appropriate term when searching for course content. Key to Course Descriptions may be found at: **http://rcs.registrar.arizona.edu/course_descriptions_key**.

Electrical & Computer Engr (ECE)

ECE 175: Computer Programming for Engineering Applications (3 units)
Description: Fundamentals of C, complexity and efficiency analysis, numerical precision and representations, intro to data structures, structured program design, application to solving engineering problems.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $25

Course Components:	Laboratory	Required
	Lecture	Required

Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Prerequisite or concurrently enrolled in: MATH 122B or MATH 125.

ECE 201R: Geometrical and Instrumental Optics I (3 units)
Description: Basic principles of geometric optics, refraction and reflection, Gaussian optics, paraxial optics, stops and pupils, simple optical instruments.
Grading basis: Regular Grades
Career: Undergraduate

Course Components:	Discussion	May Be Offered
	Lecture	Required

Equivalent to: ECE 201R
Also offered as: OPTI 201R
Course typically offered:
Main Campus: Fall

Home department: College of Optical Sciences
Enrollment requirement: Major: OSE. (MATH 122B or MATH 125), MATH 129, PHYS 141, and MSE 110.

ECE 202R: Geometrical and Instrumental Optics II (3 units)
Description: Optical instruments, field and relay lenses, telescopes, microscopes, optical materials, achromatization, illumination, cameras, projectors.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 202R
Also offered as: OPTI 202R
Course typically offered:
Main Campus: Spring

Home department: College of Optical Sciences
Enrollment requirement: Major or Minor: OSE. OPTI 201R.

ECE 207: Elements of Electrical Engineering (3 units)
Description: Current and voltage dividers. Resistors, capacitors, inductors. Node voltage and mesh current analysis of circuits. Thevenin and Norton equivalents. AC circuits, phasors, impedance. Electromagnetic fields, electric power, transformers, magnetic materials, generators and motors. Operational amplifiers, Elements of digital circuits. Sensors and measurements of physical quantities.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: PHYS 241 or PHYS 261H.

ECE 220: Basic Circuits (5 units)
Description: Elementary, transient and sinusoidal analysis of linear circuits with laboratory. Topics include: passive sign convention, mesh and node analysis, Thevenin equivalents, op-amps, capacitance, inductance, first and second order circuits, phasors, impedance, transformers, PSpice simulation software.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $100
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: MATH 129 and (PHYS 241 or PHYS 251 or PHYS 261H).
Special Exam: Special Exam Credit Only

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

ECE 274A: Digital Logic (4 units)
Description: Number systems and coding, logic design, sequential systems, register transfer language.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $34
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: ECE 175. Prerequisite or concurrent enrollment in MATH 129.

ECE 275: Computer Programming for Engineering Applications II (3 units)
Description: C and C++ programming. Core design and analysis of engineering algorithms and structures including lists, trees, graphs, traversal, and encoding. Fundamentals of C and C++ programming languages including pointers, structures, unions, and introduction to classes. Programming design topics including memory management, abstraction and design of advanced structures, and basics of software engineering.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $25
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Major: ECE. ECE 175

ECE 299: Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

ECE 299H: Honors Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

ECE 304A: Design of Electronic Circuits (4 units)
Description: Integrated theory and design laboratory course. Current mirrors, active loads, multi-stage amplifiers, output stages, frequency response, and feedback with emphasis on design, simulations of design and laboratory verification, measurement techniques, and technical communications.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $100
Course Components: Laboratory Required
Lecture Required
Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 351C.

ECE 310: Applications of Engineering Mathematics (4 units)
Description: This course is approximately one-half linear algebra and one-half probability and statistics. Linear algebra topics include: matrix operations, systems of linear equations, determinants, Gauss-Jordan elimination, vector spaces, basis and dimension, projections, determinants, eigenvalues and eigenvectors. Probability and statistics topics include: probability, random variables, density and distribution functions, sample mean and variance, estimation and confidence intervals. An introduction to Matlab and Matlab projects.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $25
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. MATH 254 and (ECE 207 or 220) and ECE 175.

ECE 311: Engineering Ethics and Contemporary Issues (1 unit)
Description: This one (1) credit course is required of all Electrical and Computer Engineering students. No specific prior classes or prerequisites are assumed. The course is an introductory exposition of ethics and its principles in the engineering profession, and discussion of contemporary issues that stem from the impact of high technology on our daily lives. Nowadays, engineered systems are ubiquitous in almost all realms of our activity and therefore it is of paramount importance to be cognizant of how design and use of such systems may bring about profound ethical dilemmas and consequences.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Enrollment requirement: Adv Stdg: Engineering. ECE majors only.

ECE 320A: Circuit Theory (3 units)
Description: Electric circuits in the frequency domain, using sinusoidal steady-state, Laplace and Fourier methods; single-phase and three-phase power; time domain methods and convolution; transformed networks; natural frequencies; poles and zeros; two-port network parameters; and Fourier series analysis.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Advanced Standing: Engineering. Major or minor: ECE. MATH 254 and ECE 220.

ECE 330B: Computational Techniques (3 units)
Description: This course provides students with the fundamentals of computational techniques for solving numerical problems. In particular students will become familiar with techniques for numerical differentiation, numerical integration, solving differential equations (e.g., Runge-Kutta method), root finding (e.g., Newton-Raphson method), and numerical optimization (least squares method, linear programming, and stochastic optimization techniques such as simulated annealing and genetic algorithms). In addition students will be provided with a basic working knowledge of the Matlab environment: They will learn how to create, edit, compile, and run programs in Matlab. Moreover, students will be provided with a basic working knowledge of Gnuplot: They will become familiar with 2D and 3D plotting techniques. Furthermore, students will be introduced to Numerical Recipes and the GNU Scientific Library.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. MATH 223 and MATH 254 and PHYS 143 and PHYS 241 and ECE 175.

ECE 340A: Introduction to Communications (3 units)
Description: Analysis and design of analog and digital communication systems based on Fourier analysis. Topics include linear systems and filtering, power and energy spectral density, basic analog modulation techniques, quantization of analog signals, line coding, pulse shaping, AM and FM modulation, digital carrier modulation, and transmitter and receiver design concepts. Applications include AM and FM radio, television, digital communications, and frequency-division and time-division multiplexing.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 320A.

ECE 351C: Electronic Circuits (4 units)
Description: ECE 351C is a 4 unit course covering Operational amplifiers, diode circuits, circuit characteristics of bipolar and MOS transistors, MOS and bipolar digital circuits, and simulation software. The purpose of ECE 351C is to get experience with the fundamental nonlinear devices for circuit design: diodes and transistors. We'll learn how to analyze simple linear amplifier circuits with these devices, how to use small signal models, and spend a relatively small amount of time on how to build digital logic gates. More complex linear amplifier circuits are left for ECE 304.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $100

Course Components:	Laboratory	Required
	Lecture	Required

Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 320A.

ECE 352: Device Electronics (3 units)
Description: Electronic properties of semiconductors; carrier transport phenomena; P-N junctions; bipolar, unipolar, microwave and photonic devices.
Grading basis: Regular Grades
Career: Undergraduate

Course Components:	Lecture	Required

Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. Prerequisite or concurrent enrollment in ECE 351C.
Special Exam: Special Exam Credit Only

ECE 369A: Fundamentals of Computer Organization (4 units)
Description: Computer architecture is the science and art of selecting and interconnecting hardware components to create a computer that meets functional, performance and cost goals. This course qualitatively and quantitatively examines computer design trade-offs, teaches the fundamentals of computer architecture and organization, including CPU, memory, registers, arithmetic unit, control unit, and input/output components. Topics include reduced instruction set computer architectures (RISC), using the MIPS central processor as an example, interface between assembly and high level programming constructs and hardware, instruction and memory cache systems, performance evaluation, benchmarks, and use of the SPIM/WinDLX/Verilog Simulators for the MIPS architecture. ECE 369A serves students two ways. For those who will continue in computer architecture, it lays foundation of state-of-the-art techniques implemented in current and future high-performance computing platforms. For those students not continuing in computer architecture, it gives an overview of the kind of techniques used in today's microprocessors.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $25
Course Components: Laboratory Required
Lecture Required
Equivalent to: ECE 369
Course typically offered:
Main Campus: Fall

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 175 and ECE 274A.

ECE 370: Lasers and Photonics (3 units)
Description: Principles of lasers; properties and manipulation of laser light; physical effects and operating principles of photonic components and devices including light modulators, displays, and optical fibers; elements of photonic telecommunications.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 370
Also offered as: OPTI 370
Course typically offered:
Main Campus: Spring

Home department: College of Optical Sciences
Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 240, OPTI 310.

ECE 372A: Microprocessor Organization (4 units)
Description: This course is an introduction to microcontroller organization, hardware interfacing, and system design. Topics include, but are not limited to: C Programming for Microcontrollers, Memory Organization and Addressing Modes, Interrupts, Timers, Parallel and Serial Interfacing, Analog-to-Digital Conversion, Overview of Common Peripheral Components, Event-driven Software Development, and Motor Control. In addition to lectures, students will have hands-on lab assignments that provide you with the opportunity to build and utilize the PIC24F platform. Students will also have a course project in which they will propose, design/implement, and present a self-selected project, subject to approval by the instructor.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $100

Course Components:	Laboratory	Required
	Lecture	Required

Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. (ECE 207 or 220) and ECE 274A and ECE 275 (concurrent enrollment in ECE 275 ok).

ECE 373: Object-Oriented Software Design (3 units)
Description: Object oriented computing concepts, abstract data types, classes, methods, message passing, inheritance, object oriented design and architectures, class hierarchies, use case development, sequence diagrams, introduction to unified modeling language, object oriented programming languages and environments, polymorphism, dynamic binding, OO software implementation projects.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $25

Course Components:	Lecture	Required

Course typically offered:
Main Campus: Fall

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 275.

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May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

ECE 381A: Introductory Electromagnetics (4 units)
Description: Electrostatic and magnetostatic fields; Maxwell's equations; introduction to plane waves, transmission lines, and sources.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion Required
Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. MATH 223 and ECE 220.

ECE 392: Directed Research (1 - 3 units)
Description: Individual or small group research under the guidance of faculty.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Lecture May Be Offered
Repeatable: Course can be repeated for a maximum of 6 units.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

ECE 399: Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering.

ECE 399H: Honors Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering. Honors active.
Honors Course: Honors Course
Honors Course: Honors Course

ECE 403A: Mathematical Methods for Optics & Photonics (3 units)
Description: This course covers the basic mathematics needed for an in-depth understanding of the science and technology of fiber-optical communication systems. Every mathematical tool/technique developed in this course will first be motivated by the relevant application. The students are not expected to have a broad-based prior knowledge of the topics covered in this course, but they should generally be familiar with the basics of algebra, Euclidean geometry, trigonometry, integral and differential calculus, simple differential equations, and the rudiments of complex number analysis. The course will cover Complex Analysis, Fourier transform theory, and method of stationary phase (in the context of optical diffraction), vector algebra, linear algebra, ordinary and partial differential equations (e.g., Maxwell¿s electrodynamics, wave equation, diffusion equation), special functions (e.g., Bessel functions needed to study the guided modes of optical fibers), and probability theory (needed for understanding various sources of noise in communication systems, photodetection theory, digital communication via noisy channels, Information theory, etc.).
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Also offered as: OPTI 403A
Co-convened with: ECE 503A
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Students should have familiarity with basic calculus, Euclidean geometry, algebra, trigonometry and the complex number system.
Home department: College of Optical Sciences
Enrollment requirement: Major: OSE. Adv Stdg: Engineering. MATH 322.

ECE 404: Optical Spectroscopy of Materials (3 units)
Description: The course provides a survey of Optical Spectroscopic Methods and underlying phenomena for the study of materials.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Equivalent to: ECE 404, OPTI 404
Also offered as: MSE 404, OPTI 404
Co-convened with: ECE 504
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: PHYS 141 or PHYS 241, MATH 223, MSE 110, and ECE 360.
Home department: Materials Science & Engineering
Enrollment requirement: Adv Stdg: Engineering.

ECE 407: Digital VLSI Systems Design (3 units)
Description: This course covers the fundamental techniques for the design, analysis and layout of digital CMOS circuits and systems. Major topics include: MOSFET basics (structure and behavior of a MOSFET, CMOS fabrication, and design rules), detailed analysis of the CMOS inverter (static behavior, ratioed vs. ratioless design, noise margins, computing rise and fall times, delay models, resistance and capacitance estimation, design and layout of static CMOS logic gates, dynamic CMOS logic design, sequential circuit design (static and dynamic sequential circuit elements, clocking schemes and clock optimization), CMOS data path design.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 507
Course typically offered:
Main Campus: Fall

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 274A and ECE 351C.

ECE 408: Agent-Based Simulation (3 units)
Description: This course will introduce the student to: the concept of agents and multi-agent systems; the main issues in the theory and practice of multi-agent systems; the design of multi-agent systems; contemporary platforms for implementing agents and multi-agent systems; artificial life, artificial societies, N-person games. Upon completing this course, the students will understand: the notion of an agent; how agents are different from other software paradigms; the key issues associated with constructing agents, building and implementing models; the main approaches to developing agent-based simulation systems; the types of multi-agent interactions possible in such systems; the main application areas of agent-based simulation. Most importantly, they will be able to develop meaningful agent-based systems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 508
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 175.

ECE 411: Numeric Modeling of Physics & Biological Systems (3 units)
Description: This course combines themes from mechanics, electromagnetics, thermal physics, and neural networks with an introduction to numerical methods as well as the use of MATLAB. Students will become familiar with the underlying theory for a variety of systems in physics and biology (e.g., harmonic, anharmonic and coupled oscillators; electric fields of electric lenses; geo-thermal power station; and artificial neural networks), derive the necessary mathematical equations describing these systems, learn the necessary numerical methods to solve the underlying equations, and implement the system equations and numerical methods in MATLAB to simulate these systems. As a result, students will be prepared to formulate problems or model systems in physics, biology, and related disciplines, and to solve them numerically or in simulation.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 511
Course typically offered:
Main Campus: Fall

Field trip: none
Enrollment requirement: Advanced Standing: Engineering. Major: ECE

ECE 413: Web Development and the Internet of Things (3 units)
Description: This course focuses on the design, integration, and programming of web applications for the Internet of Things (IoT). Course topics include client-side dynamic web page development with HTML, CSS, JavaScript, and Ajax; server-side web application development with Node.js, MongoDB, and RESTful interfaces; and IoT device-side development using formal state-based programming and publish-subscribe interfacing. Additional topics include token-based user authentication, password hashing, responsive design, and relational databases. IoT applications covered in this course include connected cars, connected health, wearables, smart grids, smart homes, and remote measurement, among others.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 513
Enrollment requirement: Adv Stdg: Engineering. ECE 275.

ECE 414A: Photovoltaic Solar Energy Systems (3 units)
Description: This course is intended to provide an introduction to the theory and operation of different types of photovoltaic devices, the characteristics of solar illumination, and the advantages and characteristics of concentrating and light management optics. The physical limits on photovoltaic cell performance and practical device operation will be analyzed. The main device emphasis will focus on different types of silicon photovoltaics including crystalline, amorphous, multi-crystalline, and thin film solar cells. An overview of other types of photovoltaic cells including multi-junction III-V, CdTe, CuInSe2, and organics will also be given. A discussion of radiometric and spectral properties of solar illumination will be presented and the impact of these factors on solar cell design will be explored. Techniques for increasing the performance of solar cells by light trapping, photon recycling, and anti-reflection coatings will be covered. The design and operation of imaging and non-imaging concentrators will also be discussed. Basic experiments related to PV cell measurements and the optical properties of concentrators are also planned for the course.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: OPTI 414A
Also offered as: OPTI 414A
Co-convened with: ECE 514A
Course typically offered:
Main Campus: Spring

Enrollment requirement: Adv Stdg: Engineering.

ECE 415: Microelectronics Manufacturing and the Environment (3 units)
Description: This course will focus on presentation of the basic semiconductor processes which have direct environmental implications.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 415
Also offered as: CHEE 415
Co-convened with: ECE 515
Course typically offered:
Main Campus: Fall

Home department: Chemical & Environmental Engineering
Enrollment requirement: Adv Stdg: Engineering.

ECE 417: Measurement and Data Analysis in Biomedical Engineering (3 units)
Description: Topics in biomedical instrumentation, sensors, physiological measurements, analog and digital signal processing, data acquisition, data reduction, statistical treatment of data, and safety issues. Course includes both lecture and structured laboratory components.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $50
Course Components: Laboratory Required
Lecture Required
Equivalent to: ECE 417
Also offered as: BME 417
Co-convened with: ECE 517
Course typically offered:
Main Campus: Spring

Recommendations and additional information: BME 330 or Equivalent, or Instructor Consent
Home department: Biomedical Engineering
Enrollment requirement: Senior status only.

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

ECE 421: Complexity (3 units)
Description: Complexity is a new approach studying how interconnected parts give rise to the collective behavior of large systems and how the systems interact with their environment. It cuts across all traditional disciplines: science, engineering, medicine, management. This course introduces the students to:key issues associated with Complexity, main approaches to study Complexity, ways of describing complex systems, process of formation of complex systems, how local interactions give rise to global patterns of behavior, emergent phenomena, analytical and computational tools for studying Complexity, the main application areas of Complexity.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: Advanced Standing: Engineering. Major: ECE.

ECE 429: Digital Signal Processing (3 units)
Description: Discrete-time signals and systems, z-transforms, discrete Fourier transform, fast Fourier transform, digital filter design.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 529
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 340A.

ECE 430: Optical Communication Systems (3 units)
Description: Physics of optical communication components and applications to communication systems. Topics include fiber attenuation and dispersion, laser modulation, photo detection and noise, receiver design, bit error rate calculations, and coherent communications.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: OPTI 430
Also offered as: OPTI 430
Co-convened with: OPTI 530
Course typically offered:
Main Campus: Fall

Recommendations and additional information: SIE 305, ECE 340, ECE 352, ECE 381.
Home department: College of Optical Sciences
Enrollment requirement: Adv Stdg: Engineering.

ECE 434: Electrical and Optical Properties of Materials (3 units)
Description: Properties of conductors, insulators, and semiconducting materials as related to crystal structure, interatomic bonding and defect structures.The course is designed to cover electrical and optical properties of materials including all three materials classifications (conductors, insulators, semiconductors). The course content has covered all of these subject areas for at least 13 years and it recently came to our attention that the course catalog entry was truncated and incorrectly suggests that only one of these discussion areas is covered in the course.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 434, OPTI 434
Also offered as: MSE 434, OPTI 434
Course typically offered:
Main Campus: Fall

Recommendations and additional information: PHYS 241.
Home department: Materials Science & Engineering
Enrollment requirement: Adv Stdg: Engineering.

ECE 435A: Digital Communications Systems (3 units)
Description: The purpose of the course is to give students a comprehensive introduction to digital communication principles. The major part of the course is devoted to studying how to translate information into a digital signal to be transmitted, and how to retrieve the information back from the received signal in the presence of noise and intersymbol interference (ISI). Various digital modulation schemes are discussed through the concept of signal space. Analytical and simulation models for digital modulation systems are designed and implemented in the presence of noise and ISI. Optimal receiver models for digital base-band and band-pass modulation schemes are covered in detail.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 535A
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 340A.

ECE 441A: Automatic Control (3 units)
Description: Linear control system representation in time and frequency domains, feedback control system characteristics, performance analysis and stability, and design of control.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 541A
Course typically offered:
Main Campus: Fall

Enrollment requirement: Adv Stdg: Engineering. Major: ECE. ECE 320A.

ECE 442: Digital Control Systems (3 units)
Description: Modeling, analysis, and design of digital control systems; A/D and D/A conversions, Z-transforms, time and frequency domain representations, stability, microprocessor-based designs.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 542
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 320A.

ECE 446: Semiconductor Processing (3 units)
Description: Silicon and compound semiconductor materials preparation, bulk crystal growth, wafering, epitaxial growth, photolithography, doping, ion implantation, etching, oxidation, metallization, silicon and compound semiconductor device processing.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 446, NEE 446
Also offered as: MSE 446
Co-convened with:
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Home department: Materials Science & Engineering
Enrollment requirement: Adv Stdg: Engineering.

ECE 447A: Advanced Motion Control (3 units)
Description: An interdisciplinary course that investigates design and development of systems for mechanization and control of moving objects in live performance conditions.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Studio May Be Offered
Repeatable: Course can be repeated a maximum of 4 times.
Equivalent to: ECE 447A
Also offered as: TAR 447A
Home department: School of Theatre Arts
Enrollment requirement: BFA Design Tech and TAR 401.

ECE 450: Analog Integrated Circuits (3 units)
Description: Nonswitching aspects of analog integrated circuits using bipolar or CMOS technologies. Biasing, DC signal behavior, small behavior. Emphasis on use of physical reasoning, identification of circuit functions, and use of suitable approximations to facilitate understanding and analysis.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 550
Course typically offered:
Main Campus: Fall

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 351C.

ECE 451A: Introduction to Physical Electronics (3 units)
Description: This course introduces the students to the basics of physical electronics. The students are expected to learn: the motion of particles in vacuum, plasma, and solid state; the elements of quantum mechanics; statistics; device electronics. They will also learn to research the literature on selected topics.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 551A
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 381A.

ECE 456: Optoelectronics (3 units)
Description: Properties and applications of optoelectronic devices and systems. Topics include radiation sources, detectors and detector circuits, fiber optics, and electro-optical components.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 556
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 381A.

ECE 459: Fundamentals of Optics for Electrical Engineers (3 units)
Description: Introduction to diffraction and 2D Fourier optics, geometrical optics, paraxial systems, third order aberrations, Gaussian beam propagation, optical resonators, polarization, temporal and spatial coherence, optical materials and nonlinear effects, electro-optic modulators. Applications to holography, optical data storage, optical processing, neural nets, associative memory optical interconnects.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 559
Course typically offered:
Main Campus: Fall

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 381A.

ECE 462: Computer Architecture and Design (3 units)
Description: This course aims to provide a strong foundation for students to understand modern computer system architecture and to apply these insights and principles to future computer designs. It provides basic knowledge, fundamental concepts, design techniques and trade-offs, machine structures, technology factors, software implications, and evaluation methods and tools required for understanding and designing modern computer architectures including multicores, embedded systems, and parallel systems. The course is structured around the three primary building blocks of general-purpose computing systems: processors, memories, and networks. The first part of the course focuses on the fundamentals of each building block. Topics include processor microcoding and pipelining; cache microarchitecture and optimization; and network topology, routing, and flow control. The second part goes into more advanced techniques and will enable students to understand how these three building blocks can be integrated to build a modern computing system. Topics include superscalar execution, branch prediction, out-of-order execution, register renaming and memory disambiguation; VLIW, vector, and multithreaded processors; memory protection, translation, and virtualization; and memory synchronization, consistency, and coherence. The third part addresses parallel computing, including multicore architectures, datacenters and cloud computing.d others.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 562
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 369A.

ECE 465: Microelectronic Packaging Materials (3 units)
Description: Design of microelectronic packaging systems based on the electrical, thermal and mechanical properties of materials. Chip, chip package, circuit board and system designs are considered.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 465
Also offered as: MSE 465
Co-convened with:
Course typically offered:
Main Campus: Spring

Home department: Materials Science & Engineering
Enrollment requirement: Adv Stdg: Engineering.

ECE 466: Knowledge-System Engineering (3 units)
Description: Offer every two years. Knowledge systems are intelligent systems that totally or partially involve computational representation and processing of knowledge. This class introduces the principles and techniques for engineering and developing of knowledge systems. Alternative computational structures for knowledge representation, procedures and algorithms for computational processing, automated reasoning and inference from knowledge, learning new knowledge, handling uncertainty in information, knowledge-based decision networks, Distributed knowledge systems, Alternative system architectures and engines.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 566
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: ECE. Advanced Standing: Engineering.

ECE 467: Computer Graphics and CAD (3 units)
Description: Computer graphics programs and packages, 2D and 3D object transformations, homogeneous coordinates, parallel and perspective projections, clipping and view volumes, spline curves and surfaces, solid models, hidden line and surface removal, lighting and shading, graphical user interfaces, graphics file formats, Animation, implementations using OpenGL.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 567
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: ECE. Advanced Standing: Engineering.

ECE 471: Fundamentals of Information and Network Security (3 units)
Description: Shannon's approach to cryptography. Symmetric key cryptography, cryptographic hash functions, and public key cryptosystems. Authentication, key management and key distribution. Wireless and network security.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 571
Course typically offered:
Main Campus: Spring

Enrollment requirement: ECE 275 and ECE 310.

ECE 472: Design, Modeling, and Simulation for High Technology Systems in Medicine (3 units)
Description: Healthcare is changing at a very rapid pace. So does its attendant complexity and ever increasing reliance on high technology support. Technical medicine, where sophisticated, technology-based methods are used in education of healthcare professionals and in treatment of patients, is becoming a recognized discipline. Such methods require a new generation engineers, scientists, and systems designers to integrate medical and technical domains. With this in mind, this concept proposes a new honors engineering technical elective, to train innovators is this emerging domain. The course will be open to honors engineering students from all departments.In this course students will investigate current medical and health care practices using high technology. The class will focus on systems design, modeling, and simulation technologies as applied to medicine.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 572
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Mastery of material in the areas of electrical and computer engineering, or mechanical engineering, or biomedical engineering at the level commensurate with senior/junior level standing.
Field trip: No.
Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

ECE 473: Software Engineering Concepts (3 units)
Description: In-depth consideration of each of the phases of the software project life code. Object-oriented design and programming. Includes a large-scale software development project involving groups of students.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 573
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 373.

ECE 474A: Computer-Aided Logic Design (3 units)
Description: Tabular minimization of single and multiple output Boolean functions, NMOS and CMOS realizations, synthesis of sequential circuits, RTL description, laboratory exercises.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: CSC 474A
Also offered as: CSC 474A
Co-convened with: ECE 574A
Course typically offered:
Main Campus: Fall

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 274A and ECE 275.

ECE 478: Fundamentals of Computer Networks (3 units)
Description: Introduction to computer networks and protocols. Study of the ISO open systems interconnection model, with emphasis on the physical, data link, network, and transport layers. Discussion of IEEE 802, OSI, and Internet protocols.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 578
Course typically offered:
Main Campus: Fall

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 275 and ECE 310.

ECE 479: Principles of Artificial Intelligence (3 units)
Description: Provides an introduction to problems and techniques of artificial intelligence (AI). Automated problem solving, methods and techniques; search and game strategies, knowledge representation using predicate logic; structured representations of knowledge; automatic theorem proving, system entity structures, frames and scripts; robotic planning; expert systems; implementing AI systems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ECE 579
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 373.

ECE 484: Antenna Theory and Design (3 units)
Description: Introduction to the fundamentals of radiation, antenna theory and antenna array design. Design considerations for wire, aperture, reflector and printed circuit antennas.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $50
Course Components: Lecture Required
Co-convened with: ECE 584
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 381A.

ECE 486: Microwave Engineering I: Passive Circuit Design (3 units)
Description: Review of transmission line theory; microstrip lines and planar circuits; RF/microwave network analysis; scattering parameters; impedance transformer design; filter design; hybrids and resonators; RF/microwave amplifier design; RF transceiver design; RF/microwave integrated circuits.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $47
Course Components: Lecture Required
Co-convened with: ECE 586
Course typically offered:
Main Campus: Fall

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 381A.

ECE 488: Microwave Engineering II: Active Circuit Design (3 units)
Description: Planar active microwave circuits, diode and transistor characteristics, mixers, amps, oscillators, and frequency multipliers. Students will design circuits with CAD tools, fabricate in clean room, and measure performance in the lab.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $41
Course Components: Lecture Required
Co-convened with: ECE 588
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing: Engineering. Major: ECE. ECE 486.

ECE 492: Directed Research (1 - 3 units)
Description: Individual or small group research under the guidance of faculty.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Lecture May Be Offered
Repeatable: Course can be repeated for a maximum of 6 units.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

ECE 493: Internship (1 - 12 units)
Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 1 times.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

ECE 493A: Manufacturing (3 units)
Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Recommendations and additional information: Junior status.
Enrollment requirement: Adv Stdg: Engineering.

ECE 494A: Senior Practicum in Design (3 units)
Description: The practical application, on an individual basis, of previously studied theory and the collection of data for future theoretical interpretation.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Enrollment requirement: Adv Stdg: Engineering.
Student Engagement Activity: Professional Development
Student Engagement Competency: Professionalism

ECE 498A: Senior Capstone I (2 - 3 units)
Description: An upper division course designed to meet the capstone design requirements. This course is designed to satisfy the requirements of a communication skills emphasis course for the EE and COE degree programs, as well as the needs for a course in professionalism. It is intended to give students opportunities to practice communicating in situations typical of the engineering world.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Recommendations and additional information: Senior status required.
Enrollment requirement: Adv Stdg: Engineering.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

ECE 498B: Senior Capstone II (3 units)
Description: ECE 498B is an upper division course designed to meet the capstone design requirement. It is intended to stimulate students' creativity in their design projects via a variety of readings, exercises and writing assignments. Teamwork and interpersonal and managerial skills are also important to professional engineers, and ECE 498B attempts to give students opportunities to learn how to work successfully with others, especially toward meeting mutual goals or goals established by employers.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Recommendations and additional information: ECE 498A. Senior status required.
Enrollment requirement: Adv Stdg: Engineering.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

ECE 498H: Honors Thesis (3 units)
Description: An honors thesis is required of all the students graduating with honors. Students ordinarily sign up for this course as a two-semester sequence. The first semester the student performs research under the supervision of a faculty member; the second semester the student writes an honors thesis.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 9 units.
Enrollment requirement: Adv Stdg: Engineering. Honors active.
Honors Course: Honors Course
Honors Course: Honors Course
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

ECE 499: Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering.

ECE 499H: Honors Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering. Honors active.
Honors Course: Honors Course
Honors Course: Honors Course

ECE 500A: Photonic Communications Engineering I A (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). Each part is further broken down into three courses: PCE IA, PCE IB, and PCE IC. PCE IA covers optical fiber light guiding, wave propagation characteristics, materials properties, and fabrication. PCE IB covers optical transmitters, receivers and amplifiers. PCE IC covers communications systems, fiber optics networks, and Internet infrastructure. Sections A, B, and C are each 1 credit and can be taken in any combination. When all three sections are taken together the course is designed as a survey, from the device to the systems level, of Photonic Communications Engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: OPTI 500A
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Home department: College of Optical Sciences

ECE 500B: Photonic Communications Engineering I B (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). Each part is further broken down into three courses: PCE IA, PCE IB, and PCE IC. PCE IA covers optical fiber light guiding, wave propagation characteristics, materials properties, and fabrication. PCE IB covers optical transmitters, receivers and amplifiers. PCE IC covers communications systems, fiber optics networks, and Internet infrastructure. Sections A, B, and C are each 1 credit and can be taken in any combination. When all three sections are taken together the course is designed as a survey, from the device to the systems level, of Photonic Communications Engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: OPTI 500B
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Home department: College of Optical Sciences

ECE 500C: Photonic Communications Engineering I C (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). Each part is further broken down into three courses: PCE IA, PCE IB, and PCE IC. PCE IA covers optical fiber light guiding, wave propagation characteristics, materials properties, and fabrication. PCE IB covers optical transmitters, receivers and amplifiers. PCE IC covers communications systems, fiber optics networks, and Internet infrastructure. Sections A, B, and C are each 1 credit and can be taken in any combination. When all three sections are taken together the course is designed as a survey, from the device to the systems level, of Photonic Communications Engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: OPTI 500C
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Home department: College of Optical Sciences

ECE 500D: Photonic Communications Engineering II D (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). PCE I covers optical fiber light guiding and wave propagation characteristics, materials properties, optical transmitters, receivers and amplifiers, communications systems and fiber optics networks and the Internet. PCE II builds upon this knowledge with advanced subjects in system modeling, device integration, and systems-level engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge. The course is team taught by faculty from the Center for Integrated Access Networks (http://www.cian-erc.org/), which is a multi-institutional Engineering Research Center led by UA with partner schools: UCSD, UCLA, Columbia, Berkeley, Caltech, NSU, Tuskegee, and USC. Faculty from partner schools will deliver lectures via videoconference for live/synchronous student interaction.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: OPTI 500D
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 500A, OPTI 500B, OPTI 500C.
Home department: College of Optical Sciences

ECE 500E: Photonic Communications Engineering II E (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). PCE I covers optical fiber light guiding and wave propagation characteristics, materials properties, optical transmitters, receivers and amplifiers, communications systems and fiber optics networks and the Internet. PCE II builds upon this knowledge with advanced subjects in system modeling, device integration, and systems-level engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge. The course is team taught by faculty from the Center for Integrated Access Networks (http://www.cian-erc.org/), which is a multi-institutional Engineering Research Center led by UA with partner schools: UCSD, UCLA, Columbia, Berkeley, Caltech, NSU, Tuskegee, and USC. Faculty from partner schools will deliver lectures via videoconference for live/synchronous student interaction.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: OPTI 500E
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 500A, OPTI 500B, OPTI 500C.
Home department: College of Optical Sciences

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

ECE 500F: Photonic Communications Engineering II E (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). PCE I covers optical fiber light guiding and wave propagation characteristics, materials properties, optical transmitters, receivers and amplifiers, communications systems and fiber optics networks and the Internet. PCE II builds upon this knowledge with advanced subjects in system modeling, device integration, and systems-level engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge. The course is team taught by faculty from the Center for Integrated Access Networks (http://www.cian-erc.org/), which is a multi-institutional Engineering Research Center led by UA with partner schools: UCSD, UCLA, Columbia, Berkeley, Caltech, NSU, Tuskegee, and USC. Faculty from partner schools will deliver lectures via videoconference for live/synchronous student interaction.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: OPTI 500F
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 500A, OPTI 500B, OPTI 500C.
Home department: College of Optical Sciences

ECE 501B: Advanced Linear Systems Theory (3 units)
Description: Mathematical fundamentals for analysis of linear systems. Maps and operators in finite and infinite dimensional linear vector spaces, metric spaces, and inner-product spaces. Introduction to representation theory. Eigensystems. Spectral theorems and singular value decomposition. Continuity, convergence, and separability. Sturm-Louisville theory.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

ECE 503: Probability and Random Processes for Engineering Applications (3 units)
Description: Probability, random variables, stochastic processes, correlation functions and spectra with applications to communications, control, and computers.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: SIE 305.

ECE 503A: Mathematical Methods for Optics & Photonics (3 units)
Description: This course covers the basic mathematics needed for an in-depth understanding of the science and technology of fiber-optical communication systems. Every mathematical tool/technique developed in this course will first be motivated by the relevant application. The students are not expected to have a broad-based prior knowledge of the topics covered in this course, but they should generally be familiar with the basics of algebra, Euclidean geometry, trigonometry, integral and differential calculus, simple differential equations, and the rudiments of complex number analysis. The course will cover Complex Analysis, Fourier transform theory, and method of stationary phase (in the context of optical diffraction), vector algebra, linear algebra, ordinary and partial differential equations (e.g., Maxwell¿s electrodynamics, wave equation, diffusion equation), special functions (e.g., Bessel functions needed to study the guided modes of optical fibers), and probability theory (needed for understanding various sources of noise in communication systems, photodetection theory, digital communication via noisy channels, Information theory, etc.). Graduate-level requirements include completion of additional readings and additional problems on various homework assignments.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: OPTI 503A
Co-convened with: ECE 403A
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: Familiarity with basic calculus, Euclidean geometry, algebra, trigonometry and the complex number system.
Home department: College of Optical Sciences

ECE 503B: Software Tools for Photonics (3 units)
Description: A brief/concise course description: Many photonics software tools are available as off the shelf modeling programs, encompassing both active and passive photonics components. These products are now in use by a wide number of telecoms companies and laboratories around the world, helping to develop the next generation of telecoms components and systems. Experience in modeling enables the development of custom solutions for specialized industry telecommunication and photonics requirements
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: OPTI 503B
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: Familiarity with wave propagation analysis, component design, and network architecture as taught in OPTI/ECE 500A/B/C.
Home department: College of Optical Sciences

ECE 504: Optical Spectroscopy of Materials (3 units)
Description: The course provides a survey of Optical Spectroscopic Methods and underlying phenomena for the study of materials. Graduate-level requirements include an individual research project with written report.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Also offered as: MSE 504, OPTI 504
Co-convened with:
Course typically offered:
Main Campus: Spring (odd years only)

Home department: Materials Science & Engineering

ECE 505: Model-Integrated Computing (3 units)
Description: This course addresses modeling, metamodeling, advanced object-oriented system design, model-integrated computing, and integrated systems. Behavioral, structural, and process modeling are among the modeling approaches to be examined. Additional topics include semantic mapping, models of computation, graph rewriting, and domain-specific modeling. In lieu of a midterm and final exam, an individual project will be performed over the course of the semester, constituting a large portion of the grade.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 373. Graduate standing or consent of instructor. Recommend a strong command of C++ or Java programming language.

ECE 506: Reconfigurable Computing (3 units)
Description: In this class, we investigate the state-of-the-art in reconfigurable computing both from a hardware and software perspective; understand both how to architect reconfigurable systems and how to apply them to solving challenging computational problems. The purpose of this course is to prepare students for engaging in research on reconfigurable computing.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Digital design fundamentals, computer architecture and organization, programming language (C is a must, VHDL/Verilog knowledge preferred).

ECE 507: Digital VLSI Systems Design (3 units)
Description: This course covers the fundamental techniques for the design, analysis and layout of digital CMOS circuits and systems. Major topics include: MOSFET basics (structure and behavior of a MOSFET, CMOS fabrication, and design rules), detailed analysis of the CMOS inverter (static behavior, ratioed vs. ratioless design, noise margins, computing rise and fall times, delay models, resistance and capacitance estimation, design and layout of static CMOS logic gates, dynamic CMOS logic design, sequential circuit design (static and dynamic sequential circuit elements, clocking schemes and clock optimization), CMOS data path design. Graduate-level requirements include additional homework and term projects.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 407
Course typically offered:
Main Campus: Fall

ECE 508: Agent-Based Simulation (3 units)
Description: This course will introduce the student to: the concept of agents and multi-agent systems; the main issues in the theory and practice of multi-agent systems; the design of multi-agent systems; contemporary platforms for implementing agents and multi-agent systems; artificial life, artificial societies, N-person games. Upon completing this course, the students will understand: the notion of an agent; how agents are different from other software paradigms; the key issues associated with constructing agents, building and implementing models; the main approaches to developing agent-based simulation systems; the types of multi-agent interactions possible in such systems; the main application areas of agent-based simulation. Most importantly, they will be able to develop meaningful agent-based systems. Graduate-level requirements include completion of more sophisticated projects than undergraduates.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 408
Course typically offered:
Main Campus: Spring

Recommendations and additional information: A good command of at least one programming language.

ECE 509: Cyber Security - Concept, Theory, Practice (3 units)
Description: This course provides an introduction to technical aspects of cyber security. It describes threats and types of attacks against computers and networks to enable students to understand and analyze security requirements and define security policies. Security mechanisms and enforcement issues will be introduced. Students will be immersed in the cyber-security discipline through a combination of intense coursework, open-ended and real-world problems, and hands on experiments.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: ECE 578.

ECE 511: Numeric Modeling of Physics & Biological Systems (3 units)
Description: This course combines themes from mechanics, electromagnetics, thermal physics, and neural networks with an introduction to numerical methods as well as the use of MATLAB. Students will become familiar with the underlying theory for a variety of systems in physics and biology (e.g., harmonic, anharmonic and coupled oscillators; electric fields of electric lenses; geo-thermal power station; and artificial neural networks), derive the necessary mathematical equations describing these systems, learn the necessary numerical methods to solve the underlying equations, and implement the system equations and numerical methods in MATLAB to simulate these systems. As a result, students will be prepared to formulate problems or model systems in physics, biology, and related disciplines, and to solve them numerically or in simulation. Graduate level requirements include additional homework assignments, program simulations for various physics and biological systems, including numerical and graphical outputs, entirely from scratch (e.g., harmonic, anharmonic and coupled oscillators; electric fields of electric lenses; geo-thermal power station; and artificial neural networks).
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 411
Course typically offered:
Main Campus: Fall

ECE 512: Reverse Engineering the Fly (3 units)
Description: The outstanding performance and robustness of biological visual systems in real-world situations is giving rise to a new generation of man-made vision systems based on biomimetic principles. However, the details of biological visual organization are not readily accessible in textbooks. This course will teach a computational approach to the study of biological visual systems, focusing on the fly (Diptera) as an example case, and referring to primates for comparison. To generate an appreciation for the real-world behavior of neuronal systems, students may have an opportunity to observe live demonstrations of electrophysiology in flies, dragonflies, and grasshoppers (as time allows). Homeworks (upon which the course will be graded) will include development of Matlab scripts to implement models of the visual system. This course will emphasize the strong commonalities between insect and human vision. This course is designed to be accessible to students from a wide variety of backgrounds from engineering to biology, and will include introductory material to bring students from all backgrounds to the level of understanding required to do the homeworks. Students will complete the course with a solid foundation in the principles of visual system organization and with a set of Matlab scripts implementing these principles.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: BME 512, CSC 512, ECE 512
Also offered as: NRSC 512
Course typically offered:
Main Campus: Fall

Home department: Committee on Neuroscience

ECE 513: Web Development and the Internet of Things (3 units)
Description: This 3-unit course focuses on the design, integration, and programming of web applications for the Internet of Things (IoT). Course topics include client-side dynamic web page development with HTML, CSS, JavaScript, and Ajax; server-side web application development with Node.js, MongoDB, and RESTful interfaces; and IoT device-side development using formal state-based programming and publish-subscribe interfacing. Additional topics include token-based user authentication, password hashing, responsive design, and relational databases. IoT applications covered in this course include connected cars, connected health, wearables, smart grids, smart homes, and remote measurement, among others.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 413

ECE 514A: Photovoltaic Solar Energy Systems (3 units)
Description: This course is intended to provide an introduction to the theory and operation of different types of photovoltaic devices, the characteristics of solar illumination, and the advantages and characteristics of concentrating and light management optics. The physical limits on photovoltaic cell performance and practical device operation will be analyzed. The main device emphasis will focus on different types of silicon photovoltaics including crystalline, amorphous, multi-crystalline, and thin film solar cells. An overview of other types of photovoltaic cells including multi-junction III-V, CdTe, CuInSe2, and organics will also be given. A discussion of radiometric and spectral properties of solar illumination will be presented and the impact of these factors on solar cell design will be explored. Techniques for increasing the performance of solar cells by light trapping, photon recycling, and anti-reflection coatings will be covered. The design and operation of imaging and non-imaging concentrators will also be discussed. Basic experiments related to PV cell measurements and the optical properties of concentrators are also planned for the course. Graduate-level requirements include a research report on a topic selected from the course material.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 514A
Also offered as: OPTI 514A
Co-convened with: ECE 414A
Course typically offered:
Main Campus: Spring

ECE 515: Microelectronics Manufacturing and the Environment (3 units)
Description: This course will focus on presentation of the basic semiconductor processes which have direct environmental implications. Graduate-level requirements will include extended written analysis and oral presentation, which goes beyond the requirements for the students enrolled in CHEE 415.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ECE 515, MSE 515
Also offered as: CHEE 515, MSE 515
Co-convened with: ECE 415
Course typically offered:
Main Campus: Fall

Home department: Chemical & Environmental Engineering

ECE 517: Measurement and Data Analysis in Biomedical Engineering (3 units)
Description: Topics in biomedical instrumentation, sensors, physiological measurements, analog and digital signal processing, data acquisition, data reduction, statistical treatment of data, and safety issues. Course includes both lecture and structured laboratory components. Graduate-level requirements include building a biomedical instrument that implements a novel solution to a real-life problem. Examinations for graduate students will include additional essay questions that test ability to formulate creative solutions. Course includes both lecture and structured laboratory components.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $50
Course Components: Laboratory — May Be Offered
Lecture — Required
Equivalent to: ECE 517
Also offered as: BME 517
Co-convened with: ECE 417
Course typically offered:
Main Campus: Spring

Home department: Biomedical Engineering

ECE 521: Complexity (3 units)
Description: Complexity is a new approach studying how interconnected parts give rise to the collective behavior of large systems and how the systems interact with their environment. It cuts across all traditional disciplines: science, engineering, medicine, management. This course introduces the students to:key issues associated with Complexity, main approaches to study Complexity, ways of describing complex systems, process of formation of complex systems, how local interactions give rise to global patterns of behavior, emergent phenomena, analytical and computational tools for studying Complexity, the main application areas of Complexity. Graduate-level requirements include more sophisticated projects than undergraduates. In addition, undergraduates may work in teams while graduates must work individually.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture — Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 508. If you do not meet the prerequisites criteria you may still be able to register after consulting with the professor.

ECE 523: Engineering Applications of Machine Learning and Data Analytics (3 units)
Description: Machine learning deals with the automated classification, identification, and/or characterizations of an unknown system and its parameters. There are an overwhelming number of application driven fields that can benefit from machine learning techniques. This course will introduce you to machine learning and develop core principles that allow you to determine which algorithm to use, or design a novel approach to solving to engineering task at hand. This course will also use software technology to supplement the theory learned in the class with applications using real-world data.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: ECE 503

ECE 524: Fundamentals of Cloud Security (3 units)
Description: Cloud Computing is an emerging paradigm that aims at delivering computing, information services, and data storage as a utility service over a network (e.g., Internet). There is a strong interest in cloud computing due to their performance and host, but their rapid deployment will exacerbate the security problem. In cloud computing, organizations relinquish direct control of many security aspects to the service providers such as trust, privacy preservation, identity management, data and software isolation, and service availability. The adoption and proliferation of cloud computing and services will be severely impacted if cloud security is not adequately addressed. The main goal of this course is discuss the limitations of current cybersecurity approaches to clouds and then focus on the fundamental issues to address the cloud security and privacy such as the confidentiality, integrity and availability of data and computations in clouds. In this course we will examine cloud computing models, look into the threat model and security issues related to data and computations outsourcing, and explore practical applications to make cloud resources secure and resilient to cyber attacks.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

ECE 527: Holography and Diffractive Optics (3 units)
Description: This course describes the nature of holographic and lithographically formed diffraction gratings and the tools necessary for their design and analysis. Course topics include a description of the interference and Fourier relations that determine the amplitude of diffracted fields, analysis of volume gratings, properties of holographic recording materials, computer generated holograms, binary gratings, analysis of applications of holography including data storage, imaging systems, photovoltaic energy systems, polarization control elements, and associative memories. We will also have a number of lab demonstrations fabricating holograms in a new type of photopolymer.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ECE 527
Also offered as: OPTI 527
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 502, OPTI 505R or ECE 459 or ECE 559.
Home department: College of Optical Sciences

ECE 529: Digital Signal Processing (3 units)
Description: Discrete-time signals and systems, z-transforms, discrete Fourier transform, fast Fourier transform, digital filter design. Graduate-level requirements include additional homework and a term project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 429
Course typically offered:
Main Campus: Spring

ECE 530: Optical Communication Systems (3 units)
Description: Physics of optical communication components and applications to communication systems. Topics include fiber attenuation and dispersion, laser modulation, photo detection and noise, receiver design, bit error rate calculations, and coherent communications. Graduate-level requirements include additional homework and a term paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 530
Also offered as: OPTI 530
Co-convened with: ECE 430
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Home department: College of Optical Sciences

ECE 531: Software Defined Radio (3 units)
Description: This course covers the fundamentals of designing fully functional software defined radio systems using a hardware radio peripheral and GNU Radio software. Using the provided hardware, students will implement and design core components of physical layer communication systems such as channel estimation, equalization, forward error correction, and modulation.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: Course Prerequisites or Co-requisites 1. Python or C/C++ programming2. Linux3. ECE 340A or equivalent4. ECE 429 or equivalent Or with the consent of the instructor.

ECE 532: Digital Image Analysis (3 units)
Description: Digital image analysis, including feature extraction, boundary detection, segmentation, region analysis, mathematical morphology, stereoscopy and optical flow.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 532
Also offered as: OPTI 532
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 340.

ECE 533: Digital Image Processing (3 units)
Description: [Taught alternate years beginning Fall 2006] Image transforms, filter design, spectrum estimation, enhancement, restoration, and data compression.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 533
Also offered as: OPTI 533
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 529; Concurrent registration, ECE 503.

ECE 534: Advanced Topics in Optical and Electronic Materials (3 units)
Description: Topics to be selected from opto-electronics, wave guides, non-linear optics, nano-materials and semiconductor materials
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 3 times.
Equivalent to: ECE 534, OPTI 534
Also offered as: MSE 534, OPTI 534
Course typically offered:
Main Campus: Spring (even years only)
Online Campus: Spring (even years only)

Home department: Materials Science & Engineering

ECE 535A: Digital Communications Systems (3 units)
Description: The purpose of the course is to give students a comprehensive introduction to digital communication principles. The major part of the course is devoted to studying how to translate information into a digital signal to be transmitted, and how to retrieve the information back from the received signal in the presence of noise and intersymbol interference (ISI). Various digital modulation schemes are discussed through the concept of signal space. Analytical and simulation models for digital modulation systems are designed and implemented in the presence of noise and ISI. Optimal receiver models for digital base-band and band-pass modulation schemes are covered in detail. Graduate work will include more challenging problem sets and exam problems, and a C/C++ simulation project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 435A
Course typically offered:
Main Campus: Spring

Enrollment requirement: Adv Stdg: Engineering.

ECE 536A: Free-Space Optical Communications Systems (3 units)
Description: The purpose of the course is to give students a comprehensive introduction to free-space optical communication principles. This course offers in-depth exposition on: (1) propagation effects in free-space, both outdoor and indoor as well as deep-space; (2) channel impairments in these media including atmospheric turbulence effects and scattering effects; (3) noise sources, (4) channel capacity studies, (5) advanced modulation and multiplexing techniques for free-space applications, (6) advanced detection and channel compensation techniques; (7) diversity techniques, (8) MIMO techniques, (9) adaptive optics techniques to deal with atmospheric turbulence effects; (10) advanced coding and coded modulation techniques; and (11) software defined free-space optical communications.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: OPTI 536A
Course typically offered:
Main Campus: Spring

ECE 537: Digital Communications Systems II (3 units)
Description: Carrier and symbol timing synchronization, equalization for intersymbol interference channels, CDMA for wireless channels.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 503, ECE 535.

ECE 538: Radar Signal Processing (3 units)
Description: Radar fundamentals: radar range equation, waveforms, ambiguity functions. Signal Processing: Pulse compression, synthetic aperture radar (SAR)inverse SAR, moving target indication (MTI), Pulse-Doppler radar, space time adaptive processing (STAP).
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 340.

ECE 539: Algebraic Coding Theory (3 units)
Description: [Taught Spring semester in even-numbered years] Construction and properties of error correcting codes; encoding and decoding procedures and information rate for various codes.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ECE 539
Also offered as: MATH 539
Course typically offered:
Main Campus: Spring (even years only)

Recommendations and additional information: MATH 415A.
Home department: Mathematics

ECE 539A: From Photonics Innovation to the Marketplace (3 units)
Description: This course covers the process of technology development in the photonics industry, both from the perspective of formal processes and case studies. Key aspects of the commercialization process including intellectual property, new product development processes, technical marketing and team building are treated in an interactive program informed by the instructor's 15 years of industry experience in both large corporate R&D organizations and entrepreneurial startups. Graduate-level requirements include completing an executive summary of their business plan/invention disclosure project that is a portion of the Group Gate 2 presentation grade.grade.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: OPTI 539A
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Home department: College of Optical Sciences

ECE 541A: Automatic Control (3 units)
Description: Linear control system representation in time and frequency domains, feedback control system characteristics, performance analysis and stability, and design of control. Graduate-level requirements include evaluation on the following set of topics: Mathematical Rigor: proofs of various design guidelines; utility of signal norms as principal characteristics of a controller. Robust Control: analysis techniques for controllers with plant or other uncertainty. Project: analysis and design on a relevant novel control systems topic, using rigorous mathematics to prove properties of the system or to validate design goals, presented in the form of a conference paper. Project ideas may be developed with the instructor or graduate advisor.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 441A
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Graduate standing.

ECE 542: Digital Control Systems (3 units)
Description: Modeling, analysis, and design of digital control systems; A/D and D/A conversions, Z-transforms, time and frequency domain representations, stability, microprocessor-based designs. Graduate-level requirements include additional homework and a term project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 442
Course typically offered:
Main Campus: Spring

ECE 546: Semiconductor Processing (3 units)
Description: Silicon and compound semiconductor materials preparation, bulk crystal growth, wafering, epitaxial growth, photolithography, doping, ion implantation, etching, oxidation, metallization, silicon and compound semiconductor device processing. Graduate-level requirements include an additional research paper requiring independent research.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ECE 546
Also offered as: MSE 546
Co-convened with:
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Home department: Materials Science & Engineering

ECE 547A: Advanced Motion Control (3 units)
Description: An interdisciplinary course that investigates design and development of systems for mechanization and control of moving objects in live performance conditions. Graduate-level requirements include graduate students functioning as Team Leaders on course developed research projects. Taking additional instruction on electrical or mechanical engineering as required.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Studio May Be Offered
Repeatable: Course can be repeated a maximum of 4 times.
Equivalent to: ECE 547A, TAR 547
Also offered as: TAR 547A
Co-convened with:
Recommendations and additional information: TAR 501 , consent of instructor, TAR MFA standing.
Home department: School of Theatre, Film and Television

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-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

ECE 550: Analog Integrated Circuits (3 units)
Description: Nonswitching aspects of analog integrated circuits using bipolar or CMOS technologies. Biasing, DC signal behavior, small behavior. Emphasis on use of physical reasoning, identification of circuit functions, and use of suitable approximations to facilitate understanding and analysis. Graduate-level requirement includes greater project scope.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 450
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 351C or equivalent Electronic Circuits I course.

ECE 551A: Introduction to Physical Electronics (3 units)
Description: This course introduces the students to the basics of physical electronics. The students are expected to learn: the motion of particles in vacuum, plasma, and solid state; the elements of quantum mechanics; statistics; device electronics. They will also learn to research the literature on selected topics.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 451A
Course typically offered:
Main Campus: Spring

ECE 552: Solid-State Devices (3 units)
Description: Basic semiconductor physics and materials, PN junctions, metal semiconductor junctions/contacts. BJTs and MOSFETs, device operation, terminal behavior and frequency response, device models.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 352.

ECE 554: Electronic Packaging Principles (3 units)
Description: Introduction to problems encountered at all levels of packaging: thermal, mechanical, electrical, reliability, materials and system integration. Future trends in packaging.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: AME 554, MSE 554
Also offered as: MSE 554
Course typically offered:
Main Campus: Fall

ECE 556: Optoelectronics (3 units)
Description: Properties and applications of optoelectronic devices and systems. Topics include radiation sources, detectors and detector circuits, fiber optics, and electro-optical components. Graduate-level requirements include additional homework and a term project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 456
Course typically offered:
Main Campus: Spring

ECE 559: Fundamentals of Optics for Electrical Engineers (3 units)
Description: Introduction to diffraction and 2D Fourier optics, geometrical optics, paraxial systems, third order aberrations, Gaussian beam propagation, optical resonators, polarization, temporal and spatial coherence, optical materials and nonlinear effects, electro-optic modulators. Applications to holography, optical data storage, optical processing, neural nets, associative memory optical interconnects. Graduate-level requirements include different exam questions and/or grading.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 459
Course typically offered:
Main Campus: Fall

ECE 562: Computer Architecture and Design (3 units)
Description: This course aims to provide a strong foundation for students to understand modern computer system architecture and to apply these insights and principles to future computer designs. It provides basic knowledge, fundamental concepts, design techniques and trade-offs, machine structures, technology factors, software implications, and evaluation methods and tools required for understanding and designing modern computer architectures including multicores, embedded systems, and parallel systems. The course is structured around the three primary building blocks of general-purpose computing systems: processors, memories, and networks. The first part of the course focuses on the fundamentals of each building block. Topics include processor microcoding and pipelining; cache microarchitecture and optimization; and network topology, routing, and flow control. The second part goes into more advanced techniques and will enable students to understand how these three building blocks can be integrated to build a modern computing system. Topics include superscalar execution, branch prediction, out-of-order execution, register renaming and memory disambiguation; VLIW, vector, and multithreaded processors; memory protection, translation, and virtualization; and memory synchronization, consistency, and coherence. The third part addresses parallel computing, including multicore architectures, datacenters and cloud computing.d others. Graduate-level students will be required to complete a term paper and extra homework.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Repeatable: Course can be repeated for a maximum of 6 units.
Co-convened with: ECE 462
Course typically offered:
Main Campus: Spring

ECE 564: Advanced Topics in Computer Networks (3 units)
Description: Current state of the Internet; multimedia requirements; quality of service in IP networks; RSVP; real-time protocol (RTP); differentiated-services (Diffserv) architecture; traffic control; traffic policing and admission control; burstiness and traffic characterization; flow control; TCP enhancements; fairness and protection; packet scheduling and buffer management; inter-domain routing (BGP protocol); intra-domain routing (OSPF protocol); hierarchical routing; web caching; medium access control in wireless LANs; mobile ad hoc networking (routing and MAC protocols, power control, topology control); addressing schemes and MAC design for sensor networks; and others.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Introductory course on computer networks.

ECE 565: Microelectronic Packaging Materials (3 units)
Description: Design of microelectronic packaging systems based on the electrical, thermal and mechanical properties of materials. Chip, chip package, circuit board and system designs are considered. Graduate-level requirements include an additional term paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ECE 565
Also offered as: MSE 565
Co-convened with:
Course typically offered:
Main Campus: Spring

Home department: Materials Science & Engineering

ECE 566: Knowledge-System Engineering (3 units)
Description: Offered every two years. Knowledge systems are intelligent systems that totally or partially involve computational representation and processing of knowledge. This class introduces the principles and techniques for engineering and developing of knowledge systems. Alternative computational structures for knowledge representation, procedures and algorithms for computational processing, automated reasoning and inference from knowledge, learning new knowledge, handling uncertainty in information, knowledge-based decision networks, Distributed knowledge systems, Alternative system architectures and engines. Graduate-level requirements include a more extensive and in-depth project, have to do additional assignment or question on the exam.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 466
Course typically offered:
Main Campus: Spring

ECE 567: Computer Graphics and CAD (3 units)
Description: Computer graphics programs and packages, 2D and 3D object transformations, homogeneous coordinates, parallel and perspective projections, clipping and view volumes, spline curves and surfaces, solid models, hidden line and surface removal, lighting and shading, graphical user interfaces, graphics file formats, Animation, implementations using OpenGL. Graduate-level requirements include a more extensive and in-depth project, have to do additional assignment or additional question on the exam, be graded on a separate curve from the ECE467 students (receiving undergraduate credit), if there is a need to curve the student scores at the semesters end.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: AME 567
Also offered as: AME 567
Course typically offered:
Main Campus: Fall

ECE 568: Introduction to Parallel Processing (3 units)
Description: Overview of uniprocessor architectures, introduction to parallel processing, pipelining, vector processing, multi-processing, multicomputing, memory design for parallel computers, cache design, communication networks for parallel processing, algorithms for parallel processing.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: NEE 568
Course typically offered:
Main Campus: Spring

Recommendations and additional information: ECE 369.

ECE 569: High Performance Computing: Technology, Architecture, and Algorithms (3 units)
Description: Parallel models of computation, data flow, reduction, rediflow, VLIW, Superscalar, superpipelining, multithreaded processors, multiprocessing, distributed computing, massively parallel systems, novel technologies, fundamentals of optical computing, optical architectures, neural networks.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Knowledge of computer architecture and digital systems.

ECE 571: Fundamentals of Information and Network Security (3 units)
Description: Shannon's approach to cryptography. Symmetric key cryptography, cryptographic hash functions, and public key cryptosystems. Authentication, key management and key distribution. Wireless and network security. Graduate students will be required to submit a research paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 471
Course typically offered:
Main Campus: Spring

ECE 572: Design, Modeling, and Simulation for High Technology Systems in Medicine (3 units)
Description: Healthcare is changing at a very rapid pace. So does its attendant complexity and ever increasing reliance on high technology support. Technical medicine, where sophisticated, technology-based methods are used in education of healthcare professionals and in treatment of patients, is becoming a recognized discipline. Such methods require a new generation engineers, scientists, and systems designers to integrate medical and technical domains. With this in mind, this concept proposes a new honors engineering technical elective, to train innovators is this emerging domain. The course will be open to honors engineering students from all departments.In this course students will investigate current medical and health care practices using high technology. The class will focus on systems design, modeling, and simulation technologies as applied to medicine.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with:
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Mastery of material in the areas of electrical and computer engineering, or mechanical engineering, or biomedical engineering at the level commensurate with senior/junior level standing.
Field trip: No.

ECE 573: Software Engineering Concepts (3 units)
Description: In-depth consideration of each of the phases of the software project life code. Object-oriented design and programming. Includes a large-scale software development project involving groups of students. Graduate-level requirements include additional homework and a term project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 473
Course typically offered:
Main Campus: Spring

ECE 574A: Computer-Aided Logic Design (3 units)
Description: Tabular minimization of single and multiple output Boolean functions, NMOS and CMOS realizations, synthesis of sequential circuits, RTL description, laboratory exercises. Graduate-level requirements include additional homework and term projects.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: CSC 574A
Also offered as: CSC 574A
Co-convened with: ECE 474A
Course typically offered:
Main Campus: Fall

ECE 576A: Engineering of Computer Based Systems (3 units)
Description: The objective of this course is to provide students with methods and techniques for supporting engineering design of complex, computer based systems. A design framework combining artificial intelligence, simulation modeling, and knowledge based systems will be discussed and applied in term projects. This course focuses on the engineering of systems which comprise heterogeneous, distributed, software, hardware, communication, and other components. The class is an integral part of our design, computer simulation and modeling, codesign, and high-level systems analysis and synthesis track. A semester project will focus on an application selected to integrate students' background, expertise, current graduate work, and interests. This class provides a methodological and theoretical foundation for ECE 576B.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 373 and ECE 479.

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-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

ECE 576B: Embedded System Design and Optimization (3 units)
Description: The focus of this course is on embedded system design, synthesis, and optimizations, also known as Electronic System Level (ESL) design. The coverage of ESL design will highlight the methods and challenges in developing embedded systems that require the tight integration of hardware and software components. In other words, the course will provide an under the hood look into how embedded systems (e.g. your smartphone, vehicle electronics) work. The course covers many aspects of embedded systems design, from system-level modeling to dynamic runtime optimizations to a brief overview of real-time software systems. The course also includes a in-depth discussion of the simulation and modeling aspects behind SystemC and transaction-level modeling (TLM), providing a detailed look into delta cycle simulation methods (similar to simulations methods used for Verilog and VHDL simulators).
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: ECE 274A, ECE 275, and ECE 576A.

ECE 577: Computer System and Network Evaluation (3 units)
Description: Theoretical foundations of the analysis and performance evaluation of computer systems and networks (wired and wireless); queueing systems in telecommunication networks; teletraffic modeling and characterization; networks of queues; scheduling and priority disciplines; heavy traffic approximation, MVA analysis; closed- and open-loop systems; operational laws; discrete-event simulations of networks.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: ECE 503.

ECE 578: Fundamentals of Computer Networks (3 units)
Description: Introduction to computer networks and protocols. Study of the ISO open systems interconnection model, with emphasis on the physical, data link, network, and transport layers. Discussion of IEEE 802, OSI, and Internet protocols. Graduate-level requirements include additional homework and assignments.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 478
Course typically offered:
Main Campus: Fall

ECE 579: Principles of Artificial Intelligence (3 units)
Description: Provides an introduction to problems and techniques of artificial intelligence (AI). Automated problem solving, methods and techniques; search and game strategies, knowledge representation using predicate logic; structured representations of knowledge; automatic theorem proving, system entity structures, frames and scripts; robotic planning; expert systems; implementing AI systems. Graduate-level requirements include additional assignments.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ECE 479
Course typically offered:
Main Campus: Spring

ECE 581A: Electromagnetic Field Theory (3 units)
Description: Time-harmonic fields; fundamental theorems and concepts; rectangular and circular waveguides and resonators; apertures in ground planes, cylinders, and wedges; scattering by cylinders and wedges.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: MATH 422.

ECE 581B: Electromagnetic Field Theory (3 units)
Description: Spherical geometries; interface problems; perturbational techniques; integral equations; asymptotic techniques; introduction to transient fields.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: ECE 581A

ECE 584: Antenna Theory and Design (3 units)
Description: Introduction to the fundamentals of radiation, antenna theory and antenna array design. Design considerations for wire, aperture, reflector and printed circuit antennas. Graduate-level requirements include additional homework and a term project.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $50
Course Components: Lecture Required
Co-convened with: ECE 484
Course typically offered:
Main Campus: Spring

ECE 586: Microwave Engineering I: Passive Circuit Design (3 units)
Description: Review of transmission line theory; microstrip lines and planar circuits; RF/microwave network analysis; scattering parameters; impedance transformer design; filter design; hybrids and resonators; RF/microwave amplifier design; RF transceiver design; RF/microwave integrated circuits. Graduate-level requirements include additional homework and a term project.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $47
Course Components: Lecture Required
Equivalent to: GEOS 586
Co-convened with: ECE 486
Course typically offered:
Main Campus: Fall

ECE 587L: Photonic Communications Laboratory (1 unit)
Description: This course is designed to provide the hands-on experience needed to master the basic concepts and laboratory techniques of optical fiber technology.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Also offered as: OPTI 587L
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Some knowledge of EM and semiconductor devices will be helpful.
Home department: College of Optical Sciences

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-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

ECE 588: Microwave Engineering II: Active Circuit Design (3 units)
Description: Planar active microwave circuits, diode and transistor characteristics, mixers, amps, oscillators, and frequency multipliers. Students will design circuits with CAD tools, fabricate in clean room, and measure performance in the lab. Graduate-level requirements include extra problems involving more challenging concepts and indepth knowledge of the material.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $41
Course Components: Lecture Required
Co-convened with: ECE 488
Course typically offered:
Main Campus: Spring

Recommendations and additional information: ECE 586 or equivalent course.

ECE 589: Atmospheric Electricity (3 units)
Description: Introduction to sources and chemistry of atmospheric ions, fair weather electricity, the global circuit, electrical structure of clouds, thunderstorm electrification, lightning, lightning electromagnetic fields, mechanisms of lightning damage and lightning protection. Graduate-level requirements include different homework assignments and tests.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ECE 589
Also offered as: ATMO 589
Co-convened with: ECE 489
Course typically offered:
Main Campus: Spring (odd years only)

Home department: Hydrology and Atmospheric Sciences

ECE 591: Preceptorship (1 - 3 units)
Description: Specialized work on an individual basis, consisting of instruction and practice in actual service in a department, program, or discipline. Teaching formats may include seminars, in-depth studies, laboratory work and patient study.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Course typically offered:
Main Campus: Fall, Spring, Summer

ECE 593: Internship (1 - 3 units)
Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

ECE 599: Independent Study (1 - 6 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

ECE 632: Advanced Optical Communication Systems (3 units)
Description: Advanced technologies and methods that enhance the overall optical transmission system performance and throughput, and the trade-offs related to the system engineering process. Topics include advanced chromatic dispersion compensation, PMD compensation and the nonlinearity management. The spectral efficiency limits will be described and techniques to achieve it, such as turbo equalization, forward error correction (FEC), and coded modulation. Advanced modulation formats, and constrained coding techniques suitable to deal with fiber nonlinearities will be presented. The physics behind parametric amplification will be presented as well as its application to all-optical regeneration, wavelength conversion, and multibanded switching. Other topics include soliton and dispersion-managed soliton transmission. Several proof-of-concept experiments will be demonstrated in Optical Communication Systems Laboratory (OCSL).
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 632
Also offered as: OPTI 632
Course typically offered:
Main Campus: Spring

Recommendations and additional information: ECE 340; ECE 430 or ECE 530.

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

ECE 633: Quantum Information Processing and Quantum Error Correction (3 units)
Description: This course is a self-contained introduction to quantum information, quantumcomputation, and quantum error-correction. The course starts with basic principles ofquantum mechanics including state vectors, operators, density operators,measurements, and dynamics of a quantum system and continues withfundamental principles of quantum computation, basic quantum gates, and basicquantum algorithms. A significant amount of time will be spent on quantum errorcorrection, in particular on stabilizer codes, Calderbank-Shor-Steane (CSS) codes, andquantum low-density parity-check (LDPC) codes. The next part of the course is spentinvestigating physical realizations of quantum computers, encoders and decoders;including photonic quantum realization, cavity quantum electrodynamics, and ion traps.The course concludes with quantum information theory and quantum key distribution (QKD).
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 501B and/or ECE 503.

ECE 635: Error Correction (3 units)
Description: Error correction has an essential role in ensuring integrity of data, and is at the heart of every communication, computing and data storage system. In such systems, data are protected by an error correcting code, and data bits are continuously being monitored, possible errors diagnosed and corrected by a decoding algorithm. Modern coding theory views codes as graphical models and treats decoding algorithms as probabilistic inference. This graduate course first introduces fundamental coding theory concepts and then focuses on modern coding theory. The treatment is self-contained and includes the necessary background in finite fields and probabilistic inference. We introduce codes on graphs such as low-density parity check (LDPC) codes and their iterative decoding algorithms. We also study codes used in classical and quantum computing and communications systems.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 503.

ECE 636: Information Theory (3 units)
Description: [Taught alternate years 2000-2001] Definition of a measure of information and study of its properties; introduction to channel capacity and error-free communications over noisy channels; rate distortion theory; error detecting and correcting codes.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: MATH 636
Also offered as: MATH 636
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 503.

ECE 637: Channel Coding (3 units)
Description: [Taught alternate years 2001-2002] A rigorous course in channel coding fundamentals, including BCH/RS codes, trellis codes, turbo codes, and low-density parity check codes.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 503, ECE 535; at least second year graduate student.

ECE 638: Wireless Communications (3 units)
Description: This course will cover advanced topics in wireless communications for voice, data, and multimedia. It begins with a brief overview of current wireless systems and standards. It then characterizes the wireless channel, including path loss for different environments, random log-normal shadowing due to signal attenuation, and the flat and frequency-selective properties of multipath fading. Next it examines the fundamental capacity limits of wireless channels and the characteristics of the capacity-achieving transmission strategies. The next focus will be on practical digital modulation techniques and their performance under wireless channel impairments. The next part of the course is devoted to coding for wireless channels, adaptive modulation and adaptive coding. A significant amount of time will be spent on multiple antenna techniques: MIMO channel model, MIMO channel capacity, and space-time coding. The section on multicarrier modulation provides comprehensive treatment of orthogonal frequency-division multiplexing (OFDM). The course concludes with ultra-wideband (UWB) communications, software-defined radio and cognitive radio
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

ECE 639: Detection and Estimation in Engineering Systems (3 units)
Description: Communication, detection and estimation as statistical inference problems. Optimal detection in the presence of Gaussian noise. Extraction of signals in noise via MAP and MMSE techniques.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: ECE 503.

ECE 677: Distributed Computing Systems (3 units)
Description: Design, architecture and programming of distributed computing systems. The course consists of three parts: 1) Networks and Protocols in high performance distributed systems; 2) Architectural issues of designing and implementing disturbed systems (distributed operating systems, distributed file systems, concurrency control and redundancy management, load balancing, and security); and 3) Distributed computing paradigms (shared memory, message passing, and web based computing, virtual computing, and Grid computing).
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

ECE 678: Wireless Protocols (3 units)
Description: Protocols for wireless LANs, mesh networks; routing for ad hoc and sensor networks; data aggregation and clustering in sensor networks; scheduling mechanisms; transport protocols for wireless and sensor networks; fairness issues; interoperability between wired and wireless networks; protocols for cognitive radio networks; protocols for wireless networks with directional transmission capabilities
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: ECE 578 or CSC 525 or equivalent.

ECE 693: Internship (2 - 3 units)
Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

ECE 695: Colloquium (1 unit)
Description: This course is designed to orient Electrical and Computer Engineering students to the PhD program. Students will learn about the requirements for the PhD program and develop strategies for successfully achieving those requirements. Students will be required to attend sessions to learn about different research opportunities associated with Electrical and Computer Engineering. Students will develop skills in effectively communicating technical concepts and ideas that are presented at these sessions.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Colloquium Required
Course typically offered:
Main Campus: Fall

ECE 696B: Advanced Topics in Electrical Engineering (3 units)
Description: The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.
Grading basis: Regular Grades
Career: Graduate
Course Components: Seminar Required
Repeatable: Course can be repeated a maximum of 3 times.
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: Consent of instructor.

ECE 699: Independent Study (1 - 6 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

ECE 799: Independent Study (1 - 6 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

ECE 900: Research (1 - 16 units)
Description: Individual research, not related to thesis or dissertation preparation, by graduate students.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

ECE 909: Master's Report (1 - 16 units)
Description: Individual study or special project or formal report thereof submitted in lieu of thesis for certain master's degrees.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.

ECE 910: Thesis (1 - 16 units)
Description: Research for the master's thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

ECE 920: Dissertation (1 - 9 units)
Description: Research for the doctoral dissertation (whether library research, laboratory or field observation or research, artistic creation, or dissertation writing).
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer