ELECTRICAL & COMPUTER ENGINEERING (ECE)

ECE 100. Introduction to Electrical and Computer Engineering. 3 Credit Hours.
Introduction to Electrical and Computer Engineering (ECE) for high school students interested in science and technology. The course covers important thematic units of the discipline: electronics, digital design, computer programming and signal processing. Emphasis on hands-on experience in the use of laboratory instrumentation, circuit construction and computer simulation.
Components: LEC.
Grading: GRD.
Typically Offered: Summer.

ECE 101. Introduction to Mobile Computing. 3 Credit Hours.
Introduction to Mobile Computing for high school students interested in application development for mobile systems. The course provides a hands-on approach to the design, development and testing of mobile applications using the latest modern tools. Students start with the basic components used to build applications and continue to more advanced features of mobile devices such as digital cameras, location services, multimedia and more. A strong emphasis is placed on hands-on experience to demonstrate the concepts, culminating in a working mobile application.
Requisite: Summer Scholars Program.
Components: LEC.
Grading: GRD.
Typically Offered: Summer.

ECE 102. Python Programming for FinTech. 3 Credit Hours.
This course covers the fundamentals of programming logic and structured programming principles including problem-solving, algorithm design, and program development using Python with a focus on financial programming applications. The course introduces the student to object-oriented programming through a study of the concepts of program specification and design, algorithm development, and coding and testing using a modern software development environment. Students learn how to write programs in an object-oriented high-level programming language (Python).
Components: LEC.
Grading: GRD.
Typically Offered: Summer.

ECE 103. Foundation of FinTech and Blockchain Technologies. 3 Credit Hours.
This course is an introduction to Blockchain technology and the application of technology in Finance (FinTech). The course is an overview course covering multiple disciplines of technology and how they are individually and collectively applied in financial systems, transactions, payments, and data lifecycles. The course aims to develop a student's understanding of key technological components such as cloud computing, Internet of Things(IoT), Big Data and Machine Learning, Artificial Intelligence, Blockchain technologies, and data security and privacy as they relate to financial transactions, financial institutions, public and private business entities, governments, regulations and an overall monetary system. The course will specifically focus on Blockchain technologies and cryptocurrencies as they relate to financial transactions, financial institutions, public and private business entities, governments, regulations, and an overall monetary system. The course will explore the use of cryptocurrencies and NFTs around the world and in the metaverse and their impact on world financial environments. The topics will include strategies for using cryptocurrencies in payment systems and mobile payment platforms, banking systems, and discussions of trading systems, smart contracts, international payment, and remittance systems, and metaverse asset creation and acquisitions. The course will also attach importance to the regulatory frameworks and constraints governing financial systems and transactions and how such regulatory schemes protect consumers and monetary systems and how they could affect or even dictate aspects of technical architectures and platforms.
Components: LEC.
Grading: GRD.
Typically Offered: Summer.

ECE 110. Introduction to Innovation: Learning About Innovation by Innovating. 3 Credit Hours.
Introduction to diverse methods and tools that promote and nurture student creativity, entrepreneurship, team-work, and skills for creating business plans that consider ethical, global and financial issues. Students will learn to use the Maker Space facility to implement their design ideas.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 111. Introduction to Engineering I. 3 Credit Hours.
Use of engineering tools and computer techniques for problem solving, data acquisition, analysis, presentation, software design, and computer aided drafting. Development of design skills through several design and building competitions is included as well as an introduction to professional ethics, intellectual property rights, the use of MATLAB, AutoCAD, and programming in C++.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 112. Introduction to Engineering II. 2 Credit Hours.
Course is designed to provide first-year undergraduate students with an introduction to some key electrical and computer engineering concepts and topics by discussing their roles in some of the commonly used electrical and computer engineering systems. Numerical examples, circuit simulations, and computer programming are introduced through the use of MATLAB, microcontroller programming languages, and PSpice. Hands-on experience are provided through a project where the students design, assemble, program, and test a microcontroller-based mobile robot with a variety of sensing devices. Should be taken as a freshman only; otherwise to be replaced by a technical elective.
Prerequisite: ECE 111.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 118. Introduction to Programming. 3 Credit Hours.
Introduction to computing, problem solving, program design, C++ language fundamentals, and software engineering principles. Software design projects are included.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 123. Explorations in Engineering. 3 Credit Hours.
Introduction to engineering for non-engineers with emphasis on real-world engineering systems and services which are changing the way we live, communicate, learn, play, and care for ourselves, our communities and our planet. Students will learn how to use modern tools to observe and design simple engineering systems.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 201. Electrical Circuit Theory. 3 Credit Hours.
Fundamentals of DC-AC circuit laws, including steady state and transient analysis. Lecture, 3 hours.
Prerequisite: MTH 162.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 202. Electronics I. 3 Credit Hours.
Semiconductor physics and devices. Diodes, bipolar-junction transistors (BJT). Introduction to field-effect transistors (FETs) and Operational Amplifiers. Emphasis on dc and ac analysis of electronic circuits. Use of CAD tools such as PSpice.
Prerequisite: ECE 201.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 203. Electrical Circuits Laboratory. 1 Credit Hour.
Laboratory work employing the techniques of circuit theory to physical components, devices, and circuits. Use of electronic computing techniques to relate analytical and empirical investigations. Laboratory, 3 hours.
Prerequisite: ECE 201.
Components: LAB.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 204. Electrical Circuits Laboratory. 1 Credit Hour.
Laboratory work employing the techniques of circuit theory to physical components, devices, and circuits. Use of electronic computing techniques to relate analytical and empirical investigations. Laboratory, 3 hours.
Prerequisite: ECE 201.
Components: LAB.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 205. Principles of Electrical Engineering--I. 3 Credit Hours.
Fundamentals of DC and AC Circuits and a survey of Electrical Machinery and Electronics. Not open to students with credits in ECE 201. Lecture, 3 hours.
Prerequisite: MTH 162.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 206. Circuits, Signals, and Systems. 3 Credit Hours.
This course teaches the basics of continuous-time signals and systems with an emphasis on circuits as motivating examples. Topics include signals and linear time-invariant systems, convolution, stability, Laplace Transform, transfer function, poles and zeros, s-domain circuit analysis, feedback control, Fourier Series and Transform, Bode plots, analog filters.
Pre-requisite: ECE 201 And MTH 311.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 211. Logic Design. 3 Credit Hours.
Boolean algebra and its applications in analysis and design of logic circuits. Introduction to SSI and MSI circuits as building blocks, memory elements, and analysis and synthesis of synchronous and asynchronous sequential systems are discussed.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 212. Processors: Hardware, Software, and Interfacing. 3 Credit Hours.
Architecture and operation of modern microprocessor based computer systems and microcontrollers. Assembly language and applications with hands on experience. Lecture, 3 hours; laboratory, 3 hours.
Prerequisite: ECE 118 and ECE 211/304.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 218. Data Structures. 3 Credit Hours.
Continuation of Programming with emphasis on C++ and the skills required of a c apable programmer. Essential data structures and algorithms, and introducing al gorithm analysis. Basic sorting, searching, and data management. Dynamic and st atic memory management. Object oriented programming.
Prerequisite: ECE 118.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 301. Electromagnetic Field Theory. 3 Credit Hours.
Vector analysis, static and time-varying fields, Maxwell's equations, propagati on of electromagnetic waves, and transmission line theory and applications are discussed.
Prerequisite: PHY 223 and MTH 210.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 302. Electronics II. 3 Credit Hours.
Continuation of ECE 202. Emphasis on integrated circuits. Field-effect transistors (FETs). Application of operational amplifiers and other integrated circuits. Frequency response of amplifiers. Use of CAD tools as PSpice.
Prerequisite: ECE 305 Or ECE 202.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 303. Electronics Laboratory. 1 Credit Hour.
Laboratory course in conjunction with courses ECE 202 and 302.
Prerequisite: ECE 203 or 204. Or Pre/Corequisite: ECE 302 or 306.
Components: LAB.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 304. Logic Design. 3 Credit Hours.
Boolean algebra and its applications in analysis and design of logic circuits. Introduction to SSI and MSI circuits as building blocks, memory elements, and analysis and synthesis of synchronous and asynchronous sequential systems are discussed.
Components: LEC.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 305. Electronics I. 3 Credit Hours.
Semiconductor physics and devices. Diodes, bipolar-junction transistors (BJT). Introduction to field-effect transistors (FETs) and Operational Amplifiers. Emphasis on dc and ac analysis of electronic circuits. Use of CAD tools such as PSpice.
Prerequisite: ECE 201.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 306. Electronics II. 3 Credit Hours.
Continuation of ECE 305. Emphasis on integrated circuits. Field-effect transistors (FETs). Application of operational amplifiers and other integrated circuits. Frequency response of amplifiers. Use of CAD tools as PSpice.
Prerequisite: ECE 202 or 305.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 307. Circuits, Signals, and Systems. 3 Credit Hours.
This course teaches the basics of continuous-time signals and systems with an emphasis on circuits as motivating examples. Topics include signals and linear time-invariant systems, convolution, stability, Laplace Transform, transfer function, poles and zeros, s-domain circuit analysis, feedback control, Fourier Series and Transform, Bode plots, analog filters.
Prerequisite: ECE 201 and MTH 311.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 308. Linear Control Systems. 3 Credit Hours.
Introduction to system theory, transfer function and state variable modeling of linear continuous time systems, root locus, Bode plot, Nyquist criterion, analysis and controller design using root locus and frequency domain techniques, proportional-integral-derivative controllers.
Prerequisite: ECE 206/307 and ECE 303/311 and MTH 210.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 310. Introduction to Engineering Probability. 3 Credit Hours.
Axioms of probability, discrete and continuous random variables, probability density functions. Expectation, conditioning, independence, functions of random variables, characteristic functions, multiple random variables. Sums of random variables, limit theorems, probability bounds, convergence concepts. Introduction to statistical analysis, estimation, and hypothesis testing. Cross-listed with IEN 310.
Prerequisite: MTH 162 and Requisite: Junior Standing.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 311. Electronics Laboratory. 1 Credit Hour.
Laboratory course in conjunction with courses ECE 305 and 306.
Prerequisite: ECE 203 or 204. Or Pre/Corequisite: ECE 302 or 306.
Components: LAB.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 312. Processors: Hardware, Software, and Interfacing. 3 Credit Hours.
Architecture and operation of modern microprocessor based computer systems and microcontrollers. Assembly language and applications with hands on experience. Lecture, 3 hours; laboratory, 3 hours.
Prerequisite: ECE 118 and ECE 211/304.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 315. Digital Design Laboratory. 1 Credit Hour.
Familiarization with properties and use of logic gates, flip-flops, digital standard components, and programmable logic devices. Design and implementation of combinational and synchronous digital systems and Computer Aided Engineering (CAE) tools for design and simulation of digital systems are also included.
Prerequisite: ECE 304 Or ECE 211.
Components: LAB.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 316. Structured Digital Design. 1 Credit Hour.
VHDL ((VHSIC (very high speed integrated circuits) hardware description languag e)) introduction and syntax. Functional and behavioral models of VHDL for desig n, testing, and simulation of digital circuits and programmable logic devices. Design and implementation of combinational and sequential digital systems using VHDL is also included.
Prerequisite: ECE 315.
Components: LAB.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 318. Algorithms. 3 Credit Hours.
Continuation of the programming sequence. Object oriented programming with C++, emphasizing the skills required of a professional programmer. Essential data structures and algorithms: trees, graphs, hash tables, parsing and text processing. Advanced sorting and data management algorithms. Advanced features of C++; effective programming with C.
Prerequisite: ECE 218.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 322. Systems Programming. 3 Credit Hours.
Practical hands-on experience with UNIX systems programming and administration. Programming using C and shell scripting languages. File systems features, multiprocessing, inter-process communication, and systems programming fundamentals are discussed.
Prerequisite: ECE 218.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 336. Discrete-Time Signals and Systems. 3 Credit Hours.
This course provides the basics connecting continuous-time (CT) and discrete-time (DT) signal processing, and an introduction to discrete-time signals and systems and applications. Topics include communication, sampling, discrete-time linear time-invariant (LTI) signals and systems, difference equations, z Transform, transform domain analysis of DT systems, DT Fourier transform (DTFT), digital filters, applications to audio, and image processing.
Prerequisite: ECE 307 Or ECE 206.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 368. Internet Computing I. 3 Credit Hours.
Principles and practices used in creating interactive Internet sites. Extensive object oriented programming in Java is taught. Use of eXtensible Markup Language (XML) to provide content description. Use of GUI components and graphics to create web based applications.
Prerequisite: ECE 218.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 376. Introduction to Cybersecurity. 3 Credit Hours.
This course will give an overview of the basic concepts of information security, various types of attacks and protections, and recovery actions. Cybersecurity concepts and case studies, Lab exercises to provide exposure to various cybersecurity monitoring tools.
Pre-Requisite: ECE 218 Or CSC 220.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 395. Undergraduate Research in Electrical and Computer Engineering. 1-3 Credit Hours.
Research and/or design projects consisting of an individual investigation of re al-world contemporary problems. Offered by special arrangement and under the s upervision of a faculty member.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 399. Cooperative Education. 1 Credit Hour.
Practical application of classroom theory through alternating semester or summer employment with firms offering positions consistent with the student's field of study. Course may be repeated.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 404. Communication Systems. 3 Credit Hours.
Introduction to digital communication, including binary and M-ary baseband and bandpass modulation over additive white Gaussian noise channels. Optimal receivers, pulse shaping for bandlimited channels, synchronization, multiple access.
Prerequisite: ECE 336 and ECE 310 or IEN 310.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 405. Solid-State Electronics. 3 Credit Hours.
Principles of semiconductor electronics, energy bands of semiconductors, Fermi level, carrier distribution, and transport mechanisms are discussed. Application of semiconductor theory to various junction and field effect devices are included.
Prerequisite: ECE 301 and PHY 223.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 412. Software Engineering and Architecture. 3 Credit Hours.
Examination of the building blocks of software systems. Requirements and specifications. Model driven architecture. Architectural and design patterns. Design and analysis for functionality and quality. Computer aided software engineering tools.
Prerequisite: ECE 318.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 413. Software Design and Verification. 3 Credit Hours.
Design for testability. Software testing methods and tools. Formal review techniques. Functional and structured testing methods and test generation.Unit-level testing. Integration, acceptance, regression, performance and stress testing. Verification methods.
Prerequisite: ECE 412/512.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 414. Computer Organization and Design. 3 Credit Hours.
Hardware structure, organization and design of computers. Design of computer arithmetic and control units, data, and instruction paths. Modern hardware description language (HDL) based design methodology. Register transfer level design of computers and digital systems. Algorithmic state machine (ASM) charts, instruction set architecture, control unit implementation, microprogramming, memory organization, pipelining, I/O system organization and high speed arithmetic units are discussed.
Prerequisite: ECE 312 Or ECE 212.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 415. Senior Project I. 1 Credit Hour.
Topics cover tasks in project planning including scheduling, documentation, communication (written and oral), financial constraints, and ethics. Students are required to present project proposals to serve as the basis for the follow-up course, ECE 416.
Senior Standing.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 416. Senior Project II. 2 Credit Hours.
The capstone design course for Electrical Engineering majors. An electrical sys tem is designed, implemented, and documented.
Prerequisite: ECE 415.
Components: THI.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 417. Embedded Microprocessor System Design. 3 Credit Hours.
Study of microcomputer system design, scientific methods for quantifying system performance, embedded controller applications using high level languages, and debugging strategies. Lecture, 1 hour; laboratory, 3 hours.
Prerequisite: ECE 218. And ECE 315. And ECE 414.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 418. Senior Project Planning. 1 Credit Hour.
The creative process of devising a product to meet customers needs including an overview of the design process, analysis of requirements, project planning, scheduling, evaluation, and documentation. Students are required to present project proposals to serve as the basis for the follow-up senior design project.
Senior Standing.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 419. Senior Project. 2 Credit Hours.
The purpose of this course is to integrate the student's knowledge in hardware, software, and project management. A major digital system is designed, implemented, debugged, and documented.
Prerequisite: ECE 418.
Components: THI.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 421. Computer Operating Systems. 3 Credit Hours.
The design and implementation of operating systems. Virtual memory and memory management, resource allocation, device drivers, process creation, control, communications and scheduling, file systems, data protection, security, parallel processing and time-sharing. The class includes a significant operating system implementation project.
Prerequisite: ECE 318.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 436. Digital Signal Processing. 3 Credit Hours.
Topics include finite length transforms (e.g., discrete Fourier transform, discrete sine and cosine transforms) and their fast computation, finite impulse response (FIR) and infinite impulse response (IIR) digital filter design, digital filter structures, finite wordlength effects on filter performance, and multirate signal processing fundamentals.
Prerequisite: ECE 336.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 437. Real-Time Digital Signal Processing Laboratory. 1 Credit Hour.
Digital signal processing hardware for real-time operation, software development tools, instruction set, and DSP experiments with audio and speech application are discussed.
Prerequisite: ECE 436. Or Corequisite: ECE 436.
Components: LAB.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 454. Digital System Design and Testing. 3 Credit Hours.
Functional building blocks and concepts of control and timing in digital design. Descriptive techniques for digital systems and design for testability.
Prerequisite: ECE 315 and 316. Corequisite: ECE 455.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 455. Design-for-Testability Laboratory. 1 Credit Hour.
Project laboratory demonstrating the techniques necessary to design, implement, and debug and test a large system. The process is carried through from conceptual design, implementation, integration, simulation, and synthesis on a FPGA chip.
Prerequisite: ECE 454. Or Corequisite: ECE 454.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 467. Database Design and Management. 3 Credit Hours.
Database systems design, modeling, implementation, management methodologies, and techniques. Different database systems are addressed including relational, object-oriented, object-relational, and distributed database systems. Internet (WWW) technology, data warehousing, and online analytical processing applications of database management systems and hands-on experience with commercial database systems is also included.
Prerequisite: ECE 322 or CSC 322.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 470. Network Client-Server Programming. 3 Credit Hours.
Introduction to server-client systems and programming. Advanced server-client design and implementation based on distributed component object model in Windows and UNIX.
Prerequisite: ECE 218.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 481. Senior Project I. 1 Credit Hour.
The creative process of devising a product to meet customers' needs including an overview of the design process, analysis of requirements, project planning, scheduling, evaluation, and documentation. Students are required to present project proposals to serve as the basis for the follow-up senior design project.
Requisite: Junior or Senior Standing.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 482. Senior Project II. 2 Credit Hours.
The capstone design course for Electrical Engineering and Computer Engineering majors. A major electrical and/or computer engineering system is designed, implemented, and documented.
Pre-requisite: ECE 481.
Components: THI.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 499. Senior-Junior Cooperative Education. 1-3 Credit Hours.
Analysis and design experience obtained in industry or government. Approved project jointly supervised and assessed by department faculty and external partner. Note: A maximum of three credits could be used to satisfy degree requirement as Technical Elective. See Bulletin for more information.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 500. Engineering Analytical Techniques. 3 Credit Hours.
Complex variables, analytic functions, power series, residue theorem, conformal mappings, series solution, Bessel functions, Legendre polynomials. singular value decomposition, vector, and matrix norms are discussed.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 502. Engineering Acoustics. 3 Credit Hours.
Introduction to basic principles of acoustics, methods of sound measurement, physiological, psychological acoustics, the acoustics of the major classes of musical instruments and speech, fundamentals of transducers, architectural acoustics, and the effects and control of noise are covered.
Prerequisite: ECE 336.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 503. Laser Communications. 3 Credit Hours.
Principles of optics, optical fibers, electro-optics, light wave propagation in free space and anisotropic media, and waveguides are discussed. Communication devices including lasers, detectors, electro-optic modulators, optical fiber communication links are covered. The course includes seven hands-on experiments.
Prerequisite: PHY 222 and PHY 223 and ECE 301 or equivalent.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 504. Fundamentals of Optical Imaging. 3 Credit Hours.
Introduction to optical imaging, optical coherence tomography imaging, fiber endoscope imaging, and spectral imaging. Learn grating diffraction, interferometer, and optical spectrometer. The course includes ten hands-on experiments. Gain system level understanding of optical coherence tomography and spectral imaging.
Prerequisites: ECE 301 or BME 545.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 505. Semiconductor Photonic Devices. 3 Credit Hours.
Operation principles and properties of semiconductor-based optoelectronic devices. Details of applications such as LED, CCD, and CMOS imagers, Laser Diodes, Solar cell, Organic devices, and Display devices.
Prerequisite: PHY 223 And ECE 302.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 506. Microfabrication. 3 Credit Hours.
Understand the standard microfabrication processes and related equipment technologies. Device design and hands-on microfabrication lab in the cleanroom. Understand various electrooptic device characterization.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 511. Computability, Complexity, and Algorithms. 3 Credit Hours.
Advanced programming techniques: dynamic programming, fast data retrieval and sorting, enumerators, data structures, and data management. The limits of software engineering, computability and models of computation, complexity analysis.
Prerequisite: ECE 318.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 512. Software Engineering and Architecture. 3 Credit Hours.
Examination of the building blocks of software systems. Requirements and speci fications. Model driven Architecture. Architectural and Design Patterns. Design and analysis for functionality and quality. Computer Aided Software Engineerin g tools.
Prerequisite: ECE 318.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 513. Software Design and Verification. 3 Credit Hours.
Design for testability. Software testing methods and tools. Formal review techn iques. Functional and structured testing methods and test generation.Unit-level testing. Integration, acceptance, regression, performance and stress testing. Verification methods.
Prerequisite: ECE 412/512.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 514. Computer Architecture. 3 Credit Hours.
Computer data and instruction types, survey of existing architectures, and the interaction between hardware and software sub-systems are discussed. Advanced topics in computer architecture.
Prerequisite: ECE 414.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 519. Design of Computing Languages. 3 Credit Hours.
Major features of modern programming languages with emphasis on design and software efficiency. Interaction between language design and the design of its compiler are included.
Prerequisite: ECE 218.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 521. Computer Operating Systems. 3 Credit Hours.
The design and implementation of operating systems. Virtual memoriy and memory management, resource allocation, device drivers, process creation, control, communications and scheduling, file systems, data protection, security, parallel processing and time-sharing. The class includes a significant operating system implementation project.
Prerequisite: ECE 318.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 532. VLSI Systems. 3 Credit Hours.
Fundamentals of MOS Technology in VLSI. System data, control flow, structures, design, layout, maskmaking, fabrication, packaging, and testing of VLSI chips are discussed. Highly concurrent Very Large Scale Integration computational systems are also covered.
Prerequisite: ECE 202. Or ECE 305. And ECE 211. Or ECE 304.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 533. Random Signals and Noise. 3 Credit Hours.
Probability models, Bayes' theorem, Limit theorems of Laplace and Poisson, functions of random variables, Central limit theorem, conditional expectation and estimation, Stochastic processes, stationarity and ergodicity, cross-spectral analysis, filtering, and prediction are discussed.
Prerequisite: ECE 310. Or IEN 310.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 534. Communication Networks. 3 Credit Hours.
Principles of digital communications, Local Area Networks (LANs), Wide Area Networks(WANs), Open systems Intercommunication (OSI), Internet reference models, internet architecture and protocols, packet switching and routing, and network performance are discussed.
Prerequisite: ECE 212. Or ECE 312. And ECE 310. Or IEN 310.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 537. Principles of Artificial Intelligence. 3 Credit Hours.
Search techniques, game trees, use of heuristics, logic, representation of knowledge, algorithms for automated reasoning including automated reasoning under imperfect information, some advanced approaches to AI-Problems such as planning.
Prerequisite: ECE 218.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 538. Introduction to Digital Image Processing. 3 Credit Hours.
Digital image representation. Image smoothing, sharpening, and transformations. Color image processing. Encoding of digital images. High level image segmentation and description techniques. Processing of image sequences.
Prerequisite: ECE 206. Or ECE 307. And MTH 210.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 539. Digital Communications. 3 Credit Hours.
Principles for the analysis and design of digital communications systems. Nyquist sampling, signal space representation, digital modulation techniques and optimal receiver design, ISI channels, error control coding, convolutional codes, Viterbi decoder, and wireless applications.
Prerequisite: ECE 404.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 540. Digital Speech and Audio Processing. 3 Credit Hours.
Introduction to human speech production, hearing, and perception. Digital speech and audio signal analysis in time and frequency, speech and audio coding, speech synthesis and recognition, language modeling, design of systems for human-machine interaction are also covered.
Prerequisite: ECE 336.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 542. MEMS: Sensors and Electronics. 3 Credit Hours.
This course will introduce the fundamentals of Microelectromechanical Systems (MEMS). An introductory foundation of MEMS concepts will be established through lectures on sensors, actuators, readout electronics, and noise. Physical principles of electromechanical, piezoresistive, capacitive, and piezoelectric sensing will be introduced. Based on these design and analysis principles the course will focus on commercial applications such as acceloremeters, biochemical sensors, RF components, microfludics, and optical devices. Sensor electronics will be discussed with a focus on integration with Complementary Metal Oxide Semiconductor (CMOS) technology.
Prerequisite: Permission of Instructor OR ECE 532.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 543. BioNanotechnology. 3 Credit Hours.
Introduction on the fundamentals of nanotechnology with a focus on Biomedical Applications. A foundation of nanotechnology concepts will be established through lectures on nanometrology with quantum physics basics, nano manufacturing tools, physical, chemical properties of nanomaterials. Application of these principles in electronics, magnetics, mechanics and optics will be discussed. Use of these nanoengineering principles and concepts to focus on biomedical technology applications such as biosensors, biomaterials, biomimetics and therapeutics
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 548. Machine Learning. 3 Credit Hours.
Fundamentals approaches to classifier induction, probabilistic and instance-based approaches, linear and polynomial classifiers, neural networks, decision trees, boosting techniques, performance evaluation, cluster analysis, reinforcement learning, fundamentals of computational learning theory.
Prerequisite: ECE 218. Or MTH 309.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 553. Neural Networks. 3 Credit Hours.
Artificial neural network algorithms and structures, learning process, perceptron, least-mean-square algorithms, multilayer perceptron, error back-propagation, radial-basis function networks, the Hopfield network, and self-organizing systems are discussed.
Prerequisite: ECE 218. Or MTH 309.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 562. Wireless and Cellular Communication. 3 Credit Hours.
Wireless Channel Characterization: path loss, shadowing, fading, frequency- selective channels, Doppler spread, and delay spread. Diversity techniques: frequency, time and space diversity. Multiple Antenna Systems: space-time coding, beamforming and layered space-time system. Digital Modulation: adaptive modulations and Orthogonal Frequency Division Multiplexing (OFDM). Cellular Concept: frequency reuse, co-channel interference and handoff. Multiple Access Methods: Frequency Division Multiple Acess (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA) and random access. CDMA: spreading codes, RAKE receiver, multiuser detection and power control.
Prerequisite: ECE 404.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 563. Wireless Communication Lab. 1 Credit Hour.
Computer simulation of path loss, shadowing and fading in wireless channels, performance of various digital modulation methods in both Gaussian and wireless channels, diversity methods, equalization methods including zero- forcing, minimum mean-square error (MMSE) and decision-feedback equalization (DFE), co-channel interfacing in celluar systems, space-time coding. Orthogonal Frequency Division Multiplexing (OFDM) systems, spreading codes for Code Division Multiple Access (CDMA) systems, and matched-filter receiver and multiuser detector for CDMA systems. Measurement of wireless signals in various environments.
Prerequisite: ECE 562.
Components: LAB.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 564. Wireless Networks. 3 Credit Hours.
Introduction of wireless channels and network. Introduction of medium access control: Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA) and Carrier Sense Multiple Access. Wireless data networksL IEEE 802.11 (WiFi), IEEE 802.16 (WiMax) and Bluetooth. Wireless network layer: mobile IP and mobile ad-hoc networks. Wireless transport layer: mobile TCP. Wireless Cellular systems: network structure and call processing of GSM and CDMA systems.
Pre or Corequisite: ECE 534.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 567. Database Design and Management. 3 Credit Hours.
Database systems design, modeling, implementation, management methodologies, and techniques. Different database systems are addressed including relational, object-oriented, object-relational, and distributed database systems. Internet (WWW) technology, data warehousing, and online analytical processing applications of database management systems and hands-on experience with commercial database systems is also included.
Prerequisite: ECE 322 or CSC 322.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 570. Network Client-Server Programming. 3 Credit Hours.
Introduction to server-client systems and programming. Advanced server-client design and implementation based on distributed component object model in Windows and UNIX.
Prerequisite: ECE 218.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 572. Object-Oriented and Distributed Database Management Systems. 3 Credit Hours.
Object-Oriented modeling concepts in languages and database systems. Object-Oriented database systems. Semantic data models, nested-relational, object-relational databases. Distributed database system. Federated Databases. Application to engineering design problems.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 574. Agent Technology. 3 Credit Hours.
Agent definition and applications, agent modeling, theories, agent representation using KIF (Knowledge Interchange Format), agent behavior, ethical and emotional agents, agent communication languages (KQML (Knowledge Query and Manipulation Language)), agent development environments and tools, agent systems (cooperative agents, interface agents, information age nts, learning agents, believable agents, agents for workgroups, mobile agents), and agent case studies are covered.
Prerequisite: ECE 537 Or ECE 637.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 576. Internet and Intranet Security. 3 Credit Hours.
Security issues and applications for securing internet and intranet-based infor mation exchange. Secure information models, security tools, security services, security protocols, electronic commerce, virtual private networks, firewalls, and security versus cost tradeoffs are covered.
Prerequisite: ECE 218 or CSC 322 or equivalent.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 577. Data Mining. 3 Credit Hours.
Introduction to the general principles of inferring useful knowledge from large data sets. Data mining algorithms, including inferring rules, linear regression, decision trees, association rules, and predictive models. Evaluation of data mining algorithms, including training, testing, prediction, comparison, cost, and cross-validation. Data mining applications.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 579. Mobile Computing. 3 Credit Hours.
Mobile computing and proxy architectures, mobile web protocols, mobile user interfaces, applications, systems-ware adaptations, mobile databases, transactions, data synchronization, privacy, authentication, and security are covered.
Prerequisite: ECE 368.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 581. Special Problems. 1-3 Credit Hours.
Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.
Components: THI.
Grading: GRD.
Typically Offered: Fall.

ECE 582. Special Problems. 1-3 Credit Hours.
Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.
Components: THI.
Grading: GRD.
Typically Offered: Spring.

ECE 583. Special Problems. 1-3 Credit Hours.
Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.
Components: LEC.
Grading: GRD.
Typically Offered: Summer.

ECE 584. Special Problems. 1-3 Credit Hours.
Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.
Components: LEC.
Grading: GRD.
Typically Offered: Summer.

ECE 590. Special Topics in Information Technology. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Information Technology.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 594. Special Topics in Computer Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Computer Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 595. Special Topics in Computer Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Computer Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 596. Special Topics in Computer Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Computer Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 597. Special Topics in Electrical Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Electrical Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 598. Special Topics in Electrical Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Electrical Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 599. Special Topics in Electrical Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Electrical Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 600. Engineering Analytical Techniques. 3 Credit Hours.
Complex variables, analytic functions, power series, residue theorem, conformal mappings, series solution, Bessel functions, Legendre polynomials. singular value decomposition, vector, and matrix norms are discussed.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 602. Engineering Acoustics. 3 Credit Hours.
Introduction to basic principles of acoustics, methods of sound measurement, physiological, psychological acoustics, the acoustics of the major classes of musical instruments and speech, fundamentals of transducers, architectural acoustics, and the effects and control of noise are covered. Prerequisite: ECE 336.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 603. Laser Communications. 3 Credit Hours.
Principles of optics, optical fibers, electro-optics, light wave propagation in free space and anisotropic media, and waveguides are discussed. Communication devices including lasers, detectors, electro-optic modulators, optical fiber communication links are covered. The course includes seven hands-on experiments.
Prerequisite: PHY 222 and PHY 223 and ECE 301 or equivalent.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 604. Fundamentals of Optical Imaging. 3 Credit Hours.
Introduction to optical imaging, optical coherence tomography imaging, fiber endoscope imaging, and spectral imaging. Learn grating diffraction, interferometer, and optical spectrometer. The course includes ten hands-on experiments. Gain system level understanding of optical coherence tomography and spectral imaging.
Prerequisites: ECE 301 or BME 545.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 605. Semiconductor Photonic Devices. 3 Credit Hours.
Principles of operation, properties semiconductor based optoelectronic devices. Details of applications such as LED, CCD and CMOS imagers, Laser Diodes, Solar cell, Organic devices and Display devices.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 606. Microfabrication. 3 Credit Hours.
Understand the standard microfabrication processes and related equipment technologies. Device design and hands-on microfabrication lab in the cleanroom. Understand various electrooptic device characterization.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 610. Software Requirements and Interaction Design. 3 Credit Hours.
Understanding user requirements is the foremost step in the software engineering process. The course discusses various requirements management techniques, processes involved in requirements engineering, and designing requirements specifications for both Agile and Waterfall methods of software development. Interaction Design (IxD) is the design of interactive products and services in which a designer's focus goes beyond the item in development to include the way users will interact with it. Interaction Design includes User Experience Design (UX) and User Interaction design. (UI).
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 612. Software Architecture and Design. 3 Credit Hours.
The software architecture of a system represents the design decisions related to overall system structure and behavior. The course discusses the design of software architectures in a systematic, predictable, repeatable, and cost-effective way. The course focuses on practical methodology for architecture and design principles that any professional software engineer can use, provides structured methods supported by reusable chunks of design knowledge. The course includes rich case studies that demonstrate how to use the methods. Building an effective architecture that enables rapid product delivery for today's needs while also addressing the long-term adaptability and maintainability of software.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 613. Software Verification and Testing. 3 Credit Hours.
The course reviews the software testing techniques that are applicable to any software product, as well as covers techniques for behavior-driven development and testing. The agile development paradigm of test-driven development is discussed. Concepts covered include test cycles, testing objectives, testing in the software development process, types of software errors, reporting and analyzing software errors, problem tracking systems, test case design, testing tools, test planning, test documentation, and managing a test group. The course also discusses how to build testing and quality into every stage of the development process and deliver a multitude of releases in an agile development environment.
Pre-Requisite: ECE 612.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 618. Software Engineering and Operations. 3 Credit Hours.
This course is designed for engineers and professionals in software who want to understand software development life cycle process. Topics such as Waterfall model, Rapid Applications Development, and Agile software development concepts are discussed with rich case studies. Operations ensure that features are running smoothly and that there are no interruptions in service - by making sure the network, storage, platform, compute, and security posture of the software after deployment in a production environment. The course also reviews DevOps lifecycle (sometimes called the continuous delivery pipeline, when portrayed in a linear fashion) is a series of iterative, automated development processes, or workflows, executed within a larger, automated, and iterative development lifecycle designed to optimize the rapid delivery of high-quality software.
Pre-Requisite: ECE 610.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 632. VLSI Systems. 3 Credit Hours.
Fundamentals of MOS Technology in VLSI. System data, control flow, structures, design, layout, maskmaking, fabrication, packaging, and testing of VLSI chips are discussed. Highly concurrent Very Large Scale Integration computational systems are also covered. * For students who are taking it as ECE 632 there will be a separate advanced final project that will include the use of all digital circuit library that will be developed in the lab exercises and in addition include an analog component to achieve a mixed signal system integration. This will require additional research study as well as comprehension of more advanced topics in VLSI. Supplemental material and additional project instruction will be delivered in the lab.
Prerequisite: ECE 202. Or ECE 305. And ECE 211. Or ECE 304.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 633. Random Signals and Noise. 3 Credit Hours.
Probability models, Bayes' theorem, Limit theorems of Laplace and Poisson, functions of random variables, Central limit theorem, conditional expectation and estimation, Stochastic processes, stationarity and ergodicity, cross-spectral analysis, filtering, and prediction are discussed.
Prerequisite: ECE 310. Or IEN 310.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 634. Communication Networks. 3 Credit Hours.
Principles of digital communications, Local Area Networks (LANs), Wide Area Networks(WANs), Open systems Intercommunication (OSI), Internet reference models, internet architecture and protocols, packet switching a3nd routing, and network performance are discussed. * For students who are taking it as ECE 634 there will be a separate requirement.
Prerequisite: ECE 212. Or ECE 312. And ECE 310. Or IEN 310.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 636. Adaptive Filters and Signal Processing. 3 Credit Hours.
Topics include linear models and estimation, orthogonality principle, Wiener filters, stochastic gradient methods, LMS and RLS algorithms, mean square error and tracking performance and applications.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 637. Principles of Artificial Intelligence. 3 Credit Hours.
Search techniques, game trees, use of heuristics, logic, representation of knowledge, algorithms for automated reasoning including automated reasoning under imperfect information, some advanced approaches to AI-Problems such as planning.
Prerequisite: ECE 218.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 638. Introduction to Digital Image Processing. 3 Credit Hours.
Digital image representation. Image smoothing, sharpening, and transformations. Color image processing. Encoding of digital images. High level image segmentation and description techniques. Processing of image sequences.
Prerequisite: ECE 206. Or ECE 307. And MTH 210.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 639. Digital Communications. 3 Credit Hours.
Principles for the analysis and design of digital communications systems. Nyquist sampling, signal space representation, digital modulation techniques and optimal receiver design, ISI channels, error control coding, convolutional codes, Viterbi decoder, and wireless applications.
Prerequisite: ECE 404.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 640. Digital Speech and Audio Processing. 3 Credit Hours.
Introduction to human speech production, hearing, and perception. Digital speech and audio signal analysis in time and frequency, speech and audio coding, speech synthesis and recognition, language modeling, design of systems for human-machine interaction are also covered.
Prerequisite: ECE 336.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 642. MEMS: Sensors and Electronics. 3 Credit Hours.
This course will introduce the fundamentals of Microelectromechanical Systems (MEMS). An introductory foundation of MEMS concepts will be established through lectures on sensors, actuators, readout electronics, and noise. Physical principles of electromechanical, piezoresistive, capacitive, and piezoelectric sensing will be introduced. Based on these design and analysis principles the course will focus on commercial applications such as acceleremeters, biochemical sensors, RF components, microfludics, and optical devices. Sensor electronics will be discussed with a focus on integration with Complementary Metal Oxide Semiconductor (CMOS) technology.
Prerequisite: Permission of Instructor OR ECE 532.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 643. BioNanotechnology. 3 Credit Hours.
Introduction on the fundamentals of nanotechnology with a focus on Biomedical Applications. A foundation of nanotechnology concepts will be established through lectures on nanometrology with quantum physics basics, nano manufacturing tools, physical, chemical properties of nanomaterials. Application of these principles in electronics, magnetics, mechanics and optics will be discussed. Use of these nanoengineering principles and concepts to focus on biomedical technology applications such as biosensors, biomaterials, biomimetics and therapeutics
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 646. Reliable Digital System Design. 3 Credit Hours.
Topics include descriptive technique for digital systems, synchronizer failure and metastability estimation, design for testability, and estimating digital system reliability. Computer-Aided Engineering (CAE) tools are also covered. Not open to students with credit in ECE 454. Offered only for Graduate students.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 648. Machine Learning. 3 Credit Hours.
Fundamentals of intelligent system design and strategies of learning capability simulation. Selected case studies of learning systems for engineering applications are included.
Prerequisite: ECE 218. Or MTH 309.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 653. Neural Networks. 3 Credit Hours.
Artificial neural network algorithms and structures, learning process, perceptron, least-mean-square algorithms, multilayer perceptron, error back-propagation, radial-basis function networks, the Hopfield network, and self-organizing systems are discussed.
Prerequisite: ECE 218. Or MTH 309.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 662. Wireless and Cellular Communication. 3 Credit Hours.
Wireless Channel Characterization: path loss, shadowing, fading, frequency- selective channels, Doppler spread, and delay spread. Diversity techniques: frequency, time and space diversity. Multiple Antenna Systems: space-time coding, beamforming and layered space-time system. Digital Modulation: adaptive modulations and Orthogonal Frequency Division Multiplexing (OFDM). Cellular Concept: frequency reuse, co-channel interference and handoff. Multiple Access Methods: Frequency Division Multiple Acess (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA) and random access. CDMA: spreading codes, RAKE receiver, multiuser detection and power control.
Prerequisite: ECE 404.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 664. Wireless Networks. 3 Credit Hours.
Introduction of wireless channels and network. Introduction of medium access control: Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA) and Carrier Sense Multiple Access. Wireless data networksL IEEE 802.11 (WiFi), IEEE 802.16 (WiMax) and Bluetooth. Wireless network layer: mobile IP and mobile ad-hoc networks. Wireless transport layer: mobile TCP. Wireless Cellular systems: network structure and call processing of GSM and CDMA systems.
Pre or Corequisite: ECE 634.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 672. Object-Oriented and Distributed Database Management Systems. 3 Credit Hours.
Object-Oriented modeling concepts in languages and database systems. Object-Oriented database systems. Semantic data models, nested-relational, object-relational databases. Distributed database system. Federated Databases. Application to engineering design problems.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 673. Information Assurance. 3 Credit Hours.
Assurance as the basis for believing an information system will behave as expected. Security design fundamentals that help create systems that are fit for their purpose and worthy of being trusted. The concepts of information assurance fundamentals. Vulnerabilities and Risk Management assessment. Security Life-Cycle, Mechanisms, Frameworks and Emerging Threats.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 674. Agent Technology. 3 Credit Hours.
Agent definition and applications, agent modeling, theories, agent representation using KIF (Knowledge Interchange Format), agent behavior, ethical and emotional agents, agent communication languages (KQML (Knowledge Query and Manipulation Language)), agent development environments and tools, agent systems (cooperative agents, interface agents, information age nts, learning agents, believable agents, agents for workgroups, mobile agents), and agent case studies are covered.
Prerequisite: ECE 537 Or ECE 637.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 675. Digital Forensics. 3 Credit Hours.
The techniques and skills to apply forensics techniques throughout an investigation life cycle while complying with legal requirements. Preservation, identification, extraction and documentation of computer evidence stored on a computer. Application of forensics techniques to investigate and analyze a host in a network, devices including mobile, and techniques to investigate and analyze network traffic.
Prerequisite: ECE 634.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 676. Internet and Intranet Security. 3 Credit Hours.
Security issues and applications for securing internet and Intranet-based information exchange. Secure information models, security tools, security services, security protocols, electronic commerce, virtual private networks, firewalls, and security versus cost tradeoffs are covered.
Prerequisite: ECE 218 or CSC 322 or equivalent.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 677. Data Mining. 3 Credit Hours.
Introduction to the general principles of inferring useful knowledge from large data sets. Data mining algorithms, including inferring rules, linear regression, decision trees, association rules, and predictive models. Evaluation of data mining algorithms, including training, testing, prediction, comparison, cost, and cross-validation. Data mining applications.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 678. Network Security. 3 Credit Hours.
Information about the threats that may be present in the cyber realm and the techniques that can be taken to protect a network and communication assets from cyber threats. Threat examination and application of security measures. Implementation of network defense measures and adjustments for cloud and hybrid applications.
Prerequisite: ECE 634.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 680. Electrical and Computer Engineering Internship. 1-3 Credit Hours.
Analysis, design, and research experience obtained at an operating and recognized industry. Approved project jointly supervised and assessed by departmental faculty and industrial partner.
Components: THI.
Grading: GRD.
Typically Offered: Fall & Spring.

ECE 681. Special Problems. 1-3 Credit Hours.
Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.
Components: THI.
Grading: GRD.
Typically Offered: Fall.

ECE 682. Special Problems. 1-3 Credit Hours.
Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.
Components: THI.
Grading: GRD.
Typically Offered: Spring.

ECE 683. Special Problems. 1-3 Credit Hours.
Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.
Components: LEC.
Grading: GRD.
Typically Offered: Summer.

ECE 684. Special Problems. 1-3 Credit Hours.
Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.
Components: LEC.
Grading: GRD.
Typically Offered: Summer.

ECE 694. Special Topics in Computer Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Computer Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 695. Special Topics in Computer Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Computer Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 696. Special Topics in Computer Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Computer Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 697. Special Topics in Electrical Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Electrical Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 698. Special Topics in Electrical Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Electrical Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 699. Special Topics in Electrical Engineering. 1-3 Credit Hours.
Lecture courses in selected areas of specialization within Electrical Engineering.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 703. Graduate Research Seminar. 1-3 Credit Hours.
Attendance and active participation in a designated semester seminar series.
Requisite: Graduate Standing.
Components: SEM.
Grading: SUS.
Typically Offered: Fall & Spring.

ECE 704. Graduate Teaching. 1-3 Credit Hours.
Teaching or assisting in a course with a substantial level of instructional responsibility. Only open to doctoral students.
Requisite: Graduate Standing.
Components: SEM.
Grading: SUS.
Typically Offered: Fall & Spring.

ECE 715. M.S. Design Project I. 3 Credit Hours.
Comprehensive M.S. design project in electrical or computer engineering. Open o nly to students in the BS/MS dual-degree program.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 716. M.S. Design Project II. 3 Credit Hours.
Continuation of ECE 715. Open only to students in the BS/MS dual-degree program.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 720. Convex Optimization. 3 Credit Hours.
This course aims to give students the tools and training to recognize convex optimization problems that arise in scientific and engineering applications, presenting the basic theory, and concentrating on modeling aspects and results that are useful in applications. Topics include convex sets, convex functions, optimization problems, optimality condition and duality, and algorithms. Applications to signal processing, machine learning and wireless communications are presented.
Prerequisite: MTH 210.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 721. Quantum Computing. 3 Credit Hours.
The field of Quantum Computing (QC) cuts across several disciplines including engineering, physics, and computer science. This course will introduce engineering students to the basics of QC including quantum bits (qubits), quantum gates, quantum decoherence, and quantum entanglement. It will discuss emerging applications of QC for quantum error correction, quantum encryption, quantum Fourier transform, and others. The course, intended for graduate students majoring in Electrical and Computer Engineering (ECE) and other engineering disciplines as well as computer science and physics, can serve as a stepping stone towards continuing research in the emerging highly impactful field.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 722. Magnetic Devices and Materials. 3 Credit Hours.
Students will be introduced to fundamental concepts of magnetism/spintronics and electromagnetism necessary to conduct state-of-the-art research and develop next-generation applications in the emerging interdisciplinary field of Advanced Materials with a focus on intelligent magnetics-based devices and materials. An emphasis will be placed to design nanomagnetic/spintronic and hybrid nano-magneto-electronic and other multifunctional nanodevices and circuits. Future applications of intelligent materials spanning from energy-efficient information processing to renewable energy and medicine will be discussed. By the end of the course, students will be fluent in solving engineering problems related to any magnetic and electromagnetic field application with a focus on the nanoscale.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 725. Statistical Signal Processing. 3 Credit Hours.
Fundamentals of statistical signal processing, focusing on detection and estimation. Detection: hypothesis testing, Neyman-Pearson criterion, Bayes risk, generalized likelihood ratio tests. Estimation: minimum variance, maximum likelihood, maximum a-posteriori, and minimum mean squared error methods, Cramer-Rao and Bayesian bounds, expectation maximization, least squares, Kalman filter, sparse solutions, applications. Students should have completed basic courses on linear algebra and probability prior to taking this course.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 730. Statistical Learning. 3 Credit Hours.
Statistical learning theory, high-dimensional data models, regression, classification, sparse kernel machines, mixture models, graphical models, Markov chain Monte Carol simulation, model assessment and selection, model inference and combining.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 735. Fundamentals of Network Science. 3 Credit Hours.
Mathematics of networks; network measures and metrics; power laws and scale-free networks; Erdos-Renyi random networks; random networks with general degree distributions; models of network formation, including preferential attachment models.
Prerequisite: MTH 210.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

ECE 738. Computer Vision. 3 Credit Hours.
Principles of computer vision. Segmentation, shape and texture analysis, 3D scene analysis, polyhedral scenes, time-varying image analysis, parallel processing algorithms, matching, and recognition are covered.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 753. Pattern Recognition and Neural Networks. 3 Credit Hours.
Statistical pattern classification, feature extraction, cluster analysis, neural net models, Hopfield net, competitive learning, multi-layer perceptron, and the Boltzmann machine are discussed.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

ECE 756. Information Theory. 3 Credit Hours.
Measure of uncertainty and entropy, two dimensional sources, noisy channels, mutual and transinformation, equivocation, efficiency and channel capacity, minimum redundancy coding, error-detecting, error-correcting codes, continuous channel without memory. Gaussian additive noise, sampling theorem, and vector space are covered.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 781. Advanced Problems. 1-3 Credit Hours.
Research and/or design projects through an individual investigation of current problems. Offered by special arrangement only.
Components: THI.
Grading: GRD.
Typically Offered: Fall.

ECE 782. Advanced Problems. 1-3 Credit Hours.
Research and/or design projects through an individual investigation of of current problems. Offered by special arrangement only.
Components: THI.
Grading: GRD.
Typically Offered: Spring.

ECE 783. Advanced Problems. 1-3 Credit Hours.
Research and/or design projects through an individual investigation of of current problems. Offered by special arrangement only.
Components: LEC.
Grading: GRD.
Typically Offered: Summer.

ECE 784. Advanced Problems. 1-3 Credit Hours.
Research and/or design projects through an individual investigation of current problems. Offered by special arrangement only.
Components: LEC.
Grading: GRD.
Typically Offered: Summer.

ECE 785. Advanced Problems in CyberSecurity. 3 Credit Hours.
Comprehensive M.S. capstone project in CyberSecurity.
Components: THI.
Grading: GRD.
Typically Offered: Spring.

ECE 792. Professional Communications Skills for Engineering Grad Students. 0 Credit Hours.
This course covers fundamental areas in professional communication for Engineering graduate students. Topic areas include: presenting research at conferences, writing manuscripts for publication, preparing the dissertation, the PhD comprehensive exams, effective teaching and mentoring, and obtaining positions in academia. Through interactive workshops, in- class exercises, brief presentations and assignments, students will have an opportunity to practice and strengthen necessary communication skills, developing collaborations, and developing effective presentation skills.
Components: LEC.
Grading: SUS.
Typically Offered: Fall & Spring.

ECE 795. Advanced Topics in Computer Engineering. 1-3 Credit Hours.
Subject matter offerings in computer engineering based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanc ed Topics".
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 796. Advanced Topics in Computer Engineering. 1-3 Credit Hours.
Subject matter offerings in computer engineering based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanc ed Topics".
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 797. Advanced Topics in Electrical Engineering. 1-3 Credit Hours.
Subject matter offerings in electrical engineering based upon student demand an d availability of faculty. Subtitles describing the topics to be offered will b e shown in parentheses in the printed class schedule, following the title "Adva nced Topics".
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 798. Advanced Topics in Electrical Engineering. 1-3 Credit Hours.
Subject matter offerings in electrical engineering based upon student demand an d availability of faculty. Subtitles describing the topics to be offered will b e shown in parentheses in the printed class schedule, following the title "Adva nced Topics".
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 799. Advanced Topics. 1-3 Credit Hours.
Subject matter offerings based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

ECE 810. Master's Thesis. 1-6 Credit Hours.
The student working on his/her master's thesis enrolls for credit, in most departments not to exceed six, as determined by his/her advisor. Credit is not awarded until the thesis has been accepted.
Components: THI.
Grading: SUS.
Typically Offered: Fall, Spring, & Summer.

ECE 820. Research in Residence. 1 Credit Hour.
Used to establish research in residence for the thesis for the master's degree after the student has enrolled for the permissible cumulative total in ECE 810 (usually six credits). Credit not granted. May be regarded as full time residence.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 825. Continuous Registration--Master's Study. 1 Credit Hour.
To establish residence for non-thesis master's students who are preparing for major examinations. Credit not granted. Regarded as full time residence.

Components: DIL.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

ECE 830. Pre-Candidacy Doctoral Dissertation. 1-12 Credit Hours.
Doctoral dissertation credits taken prior to Ph.D. student's candidacy. The student will enroll for credit as determined by his/her advisor. No more than 12 hours of ECE 830 may be taken in a regular semester; no more than six in a summer session.
Components: THI.
Grading: SUS.
Typically Offered: Fall, Spring, & Summer.

ECE 840. Post-Candidacy Doctoral Dissertation. 1-12 Credit Hours.
Doctoral dissertation credits taken after Ph.D. student has been admitted to candidacy. The student will enroll for credit as determined by his/her advisor. No more than 12 credits in ECE 840 may be taken in a regular semester; no more than six credits in a summer session.
Components: THI.
Grading: SUS.
Typically Offered: Fall, Spring, & Summer.

ECE 850. Research in Residence. 1 Credit Hour.
Used to establish research in residence for the Ph.D., after the student has been enrolled for the permissible cumulative total in appropriate doctoral research. Credit not granted. May be regarded as full-time residence as determined by the Dean of the Graduate School.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.