

# ECE-ELECTRICAL & COMPUTER ENGINEERING

## ECE 2214 Digital Design 4 Credit Hours

Prerequisite: MATH 1823 or MATH 1914. Number systems, Boolean algebra, minimization procedures, combinational logic functions, introduction to sequential logic design, finite state machines and clocked (synchronous) sequential circuits. Analysis, synthesis and implementation are appropriately emphasized. (F, Sp)

## ECE 2523 Probability, Statistics and Random Processes 3 Credit Hours

Prerequisite: ECE major or minor; MATH 2433 or MATH 2924. Covers the role of statistics in electrical and computer engineering and includes substantial exposure to applications appropriate to the discipline: basic probability; random variables, vectors and processes; time averages, expectations and laws of large numbers; stationarity, autocorrelation and spectral analysis; minimum mean squared error estimation; detection and linear filtering; IID, Markov, independent increment, counting, Gaussian and Poisson random processes. (F, Sp)

## ECE 2713 Digital Signals and Filtering 3 Credit Hours

Prerequisites: ENGR 1411 or ENGR 3511 or concurrent enrollment; CS 1313 or CS 1323 or concurrent enrollment; and MATH 2423 or 2924. Digital signals and filter, discrete Fourier A and Z transforms, sampling. (F,Sp)

## ECE 2723 Electrical Circuits I 3 Credit Hours

Prerequisites: ECE 2713 or concurrent enrollment in ECE 2713; MATH 2423 or 2924; PHYS 2524. Introduction to circuit elements and the laws of electrical science. Loop and nodal analysis solution methods. Thevenin and Norton equivalent circuits. Superposition and source transformation methods. Laplace transform analysis of electrical circuits. Guest lectures introducing advanced topics. (F, Sp)

## ECE 2970 Special Topics/Seminar 1-3 Credit Hours

1 to 3 hours. Prerequisite: Permission of instructor. May be repeated; maximum credit nine hours. Special topics or seminar course for content not currently offered in regularly scheduled courses. May include library and/or laboratory research and field projects. (Irreg.)

## ECE 3113 Energy Conversion I 3 Credit Hours

Prerequisite: ECE 2723 and ECE 3613. Survey of methods of energy conversion; field-energy force relationships, equations of motion, incremental motion transducers, transformer theory; introduction to rotating machines. (Sp)

## ECE 3223 Microprocessor System Design 3 Credit Hours

Prerequisite: ECE 3773 or concurrent enrollment. Review of clocked sequential circuits; MSI/LSI devices and applications, including registers, busing, combinational functions; use of microprocessors and logic design using microprocessors. Emphasizes assembly of full functional units into workable systems. (F, Sp)

## ECE 3323 Introduction to Solid State Electronic Devices 3 Credit Hours

Prerequisite: 3613. Introduction to quantum mechanics, crystal properties and growth of semiconductors, energy bands in solids, charge carriers in semi-conductors, excess carriers in semiconductors, and introduction to diodes and transistors. (F, Sp)

## ECE 3440 Mentored Research Experience 3 Credit Hours

0 to 3 hours. Prerequisites: ENGL 1113 or equivalent, and permission of instructor. May be repeated; maximum credit 12 hours. For the inquisitive student to apply the scholarly processes of the discipline to a research or creative project under the mentorship of a faculty member. Student and instructor should complete an Undergraduate Research & Creative Projects (URCP) Mentoring Agreement and file it with the URCP office. Not for honors credit. (F, Sp, Su)

## ECE 3613 Electromagnetic Fields I 3 Credit Hours

Prerequisite: ECE 2723 and MATH 2443 or MATH 2934 and Mathematics 3113. Electrostatic and magnetostatic fields and sources, boundary conditions; introduction to Laplace's and Poisson's equations; quasi-stationary and time-varying fields; Maxwell's equations and circuit concepts. (F, Sp)

## ECE 3723 Electrical Circuits II 3 Credit Hours

Prerequisites: ECE 2713, ECE 2723; and MATH 3113 or concurrent enrollment in MATH 3113. Analysis of electrical circuits in both time and frequency domains. Continuation of AC circuit theory, use of two port network theorems, impulse response, convolution, and differential equations. Laplace and Fourier transform analysis of electrical circuits. (F, Sp)

## ECE 3773 Electrical and Computer Engineering Circuits Laboratory 3 Credit Hours

Prerequisite: ECE 2214 and either ECE 3723 or concurrent enrollment in ECE 3723. Electrical laboratory procedures, circuit construction, debug and experimental Confirmation of the principles of circuit theory. Introduction to use of laboratory instrumentation, including skills in the use of the oscilloscope in the evaluation of DC and AC circuits. Use and application of diodes, operational amplifiers and programmable logic devices. (F, Sp)

## ECE 3793 Signals and Systems 3 Credit Hours

Prerequisites: ECE 2713, ECE 2723, MATH 3113; and MATH 3333 or concurrent enrollment in MATH 3333. Linear systems; time domain analysis; frequency domain analysis; Fourier, Laplace and Z-transforms; introduction to communications and control. (F, Sp)

## ECE 3813 Introductory Electronics 3 Credit Hours

Prerequisites: ECE 2713, and ECE 2723; CHEM 1315; and MATH 2443 or 2934 or concurrent enrollment in MATH 2443 or 2934. Small and large signal characteristics and models of electronic devices; analysis and design of elementary electronic circuits. (F, Sp)

## ECE 3873 Electrical and Computer Engineering Electronics Laboratory 3 Credit Hours

Prerequisite: ECE 2523, ECE 3723, ECE 3773, ECE 3813, and ENGR 2002 or ENGR 2003. Electronic analog circuit design, simulation, construction, debugging and measurement of circuit behavior and noise using advanced instrumentation techniques; statistics-based circuit reliability theory; independent design skills development and technical writing. (F, Sp)

## ECE 3960 Honors Reading 1-3 Credit Hours

Prerequisite: admission to Honors program. May be repeated; maximum credit six hours. Consists of topics designated by the instructor in keeping with the student's major program. Covers materials not usually presented in the regular courses. (F, Sp, Su)

## ECE 3970 Honors Seminar 1-3 Credit Hours

Prerequisite: Admission to Honors program. May be repeated; maximum credit six hours. Projects covered will vary. Deal with concepts not usually presented in regular coursework.

- ECE 3980 Honors Research 1-3 Credit Hours**  
Prerequisite: admission to Honors program. May be repeated; maximum credit six hours. provides an opportunity for the gifted Honors candidate to work on a special project in the student's field. (F, Sp, Su)
- ECE 3990 Independent Study 1-3 Credit Hours**  
1 to 3 hours. Prerequisite: permission of instructor and junior standing. May be repeated once with change of content. Independent study may be arranged to study a subject not available through regular course offerings. (F, Sp, Su)
- ECE G4113 Analysis of Electrical Transmission 3 Credit Hours**  
Prerequisite: 3113. Transmission and distribution of electrical energy, particularly addressing electrical transmission systems in the competitive energy market. (F)
- ECE 4213 Digital Signal Processing 3 Credit Hours**  
(Slashlisted with 5213) Prerequisite: 3793. Discrete-time linear systems, finite duration impulse response digital filters, finite work length effects, spectral analysis, fast Fourier-transforms, two-dimensional signal processing and applications. No student may earn credit for both 4213 and 5213. (F)
- ECE 4273 Digital Design Laboratory 3 Credit Hours**  
Prerequisites: ECE 3223 and ECE 3873. Design of digital systems with integrated circuits and MSI/LSI and microprocessor interfacing. Laboratory (F, Sp)
- ECE 4281 Engineering Co-Op Program 1 Credit Hour**  
(Crosslisted with AME, BME, C S, CEES, CH E, EPHY and ISE 4281) Prerequisite: Departmental permission and junior standing. May be repeated; maximum credit 6 hours. The Co-Op program provides students an opportunity to enhance their education via career exploration in related professional work experiences. Course assignments help students articulate their experiences by completing journals; mid-term paper; final paper and/or final presentation. Faculty receive an evaluation from the student's Co-Op supervisor who monitors performance. Faculty collaborate with the Co-Op supervisor to ensure student success. (F, Sp, Su)
- ECE 4363 Optical Engineering 3 Credit Hours**  
(Slashlisted with ECE 5363) Prerequisite: ECE 3793. Underlying theory and design of optical systems. Interference, diffraction and coherence phenomena will be examined as a basis for studying the limits of optical system performance. Other topics include a detailed study of polarization, the interaction of light with various media and geometrical optics. No student may earn credit for both 4363 and 5363. (Sp)
- ECE 4383 IC Fabrication Technology I 3 Credit Hours**  
(Slashlisted with ECE 5383) Prerequisite: 3323. A treatment of the theory and processes involved in the fabrication of integrated circuits. No student may earn credit in both 4383 and 5383. (F)
- ECE 4393 Integrated Circuit Fabrication Technology II 3 Credit Hours**  
(Slashlisted with ECE 5393) Prerequisite: senior standing and ECE 4383. Students will gain hands-on experiences of cleanroom technologies of the semiconductor industry, including epitaxial crystal growth, photolithography, and some techniques such as SEM. No student may earn credit for both 4393 and 5393. (Sp)
- ECE G4413 Introduction to Control System Engineering 3 Credit Hours**  
Prerequisite: 3793. Analysis and synthesis of control systems; control systems performance and applications. (F)
- ECE 4433 Measurement and Automation 3 Credit Hours**  
(Slashlisted with ECE 5433) Prerequisite: ECE 3793 or instructor permission or systems course in another major. Fundamentals of data acquisition and control. A series of design projects in data acquisition, logging and real-time analysis. Includes machine vision and image processing as well as vibration, motion and real-time control. No student may earn credit for both 4433 and 5433. (F)
- ECE G4523 Introduction to Communication Theory 3 Credit Hours**  
Prerequisite: ECE 2523 and ECE 3793. An introductory treatment of statistical communication theory; description of a random process by auto-correlation and power spectral density functions, sources and properties of electrical noise, the effects of modulation, detection And filtering on signal information content, bandwidth and signal-to-noise ratio. (Sp)
- ECE G4613 Computer Architecture 3 Credit Hours**  
(Crosslisted with C S 4613) Prerequisite: ECE 3223 or C S 2614 or C S 2613. Covers basic concepts of computer system design and communication between components, along with current and historical examples of computer architecture. (F, Sp)
- ECE 4623 Computer Hardware Design 3 Credit Hours**  
(Slashlisted with 5623) Prerequisite: 3223. Design of modern digital computing circuits, computer arithmetic, number systems, state machines, control units, data transfer, bus interfacing, VHDL language elements and usage, circuit simulation. No student may earn credit for both 4623 and 5623. (F)
- ECE 4643 Radio Frequency and Microwave Engineering 3 Credit Hours**  
(Slashlisted with ECE 5653) Prerequisite: ECE 3613. Analysis of radio frequency (RF) and microwave components, circuits and systems using modern engineering tools and measurement instruments. No student may earn credit for both 4643 and 5643. (Sp)
- ECE 4653 Digital Radar Systems 3 Credit Hours**  
(Slashlisted with ECE 5653) Prerequisite: ECE 3793. Modern and next-generation radar systems, with an emphasis on the digital receiver and post processing that follows the RF front-end. Several off-the-shelf receiver case studies will be conducted. These will focus on analog-to-digital converter (ADC) selection followed by software defined radio (SDR) concepts for field programmable gate array (FPGA) implementation. These receivers may also be used for communication systems and have other broad applications. No student may earn credit for both 4653 and 5653. (F)
- ECE 4663 Radar Engineering 3 Credit Hours**  
(Crosslisted with METR 4663; Slashlisted with 5663) Prerequisite: Grade of C or better in 3613, or permission. Introduction to radar system designs and applications with emphasis on weather radar; radar system architecture and their functionalities and limitations of subsystems; theories of radar detection and estimation in a noisy and cluttered environment; existing technologies and advanced techniques to improve radar performance. No student may earn credit in both 4663 and 5663. (F)
- ECE 4693 Antennas 3 Credit Hours**  
(Slashlisted with ECE 5693). Prerequisite: ECE 3613 and ECE 4703 or permission of instructor. Introduction to antenna theory and design. Course covers design, construction, and measurement of antennas including, but not limited to the following specific types; dipoles, loops, aperture, microstrip, and broadband antennas, as well as array theory. No student may earn credit for both 4693 and 5693. (Sp)

- ECE 4703 Electromagnetic Fields and Wave Propagation 3 Credit Hours**  
(Slashlisted with ECE 5703). Prerequisite: ECE 3613. Maxwell's Equations, time-harmonic fields, plane waves, reflections on interfaces, waveguides and transmission lines, radiation, and antenna basics. No student may earn credit for both 4703 and 5703. (F, Sp)
- ECE 4733 RF & Microwave Filter Design 3 Credit Hours**  
(Slashlisted with ECE 5733) Prerequisite: instructor permission. Introduction to advanced filter design. The use of filters is very widespread in all aspects of communication and radar systems. At the end of the semester, a student that has successfully embraced the subject will be able to design, fabricate, and test filters, using a range of different technologies and methods. No student may earn credit for both 4733 and 5733. (Sp)
- ECE 4773 Laboratory (Special Projects) 3 Credit Hours**  
Prerequisite: 4273 or concurrent enrollment in 4273. Individually supervised special engineering problems of experimental nature. Laboratory (F, Sp) [V].
- ECE G4813 Electronics 3 Credit Hours**  
Prerequisite: ECE 3813 and ECE 3873. Analysis and design of electronic circuits such as multi-stage amplifiers, feedback amplifiers, oscillators and power amplifiers. (Sp)
- ECE G4823 Engineering Principles of the Human Body 3 Credit Hours**  
Prerequisites: ECE 2723, PHYS 2514, MATH 2423 or 2924. Introduction to the foundational engineering approach to analyzing the human body's anatomy and physiological function. Topics include muscle and forces, fluid dynamics of the lungs and cardiovascular system, electrical signals in the body, and vision and optics of the eye. (Sp)
- ECE 4833 VLSI Digital System Design 3 Credit Hours**  
(Slashlisted with ECE 5833) Prerequisite: ECE 3223 and ECE 3873. An introduction to Very-Large-Scale Integrated (VLSI) systems design methods; complementary Metal-Oxide Semiconductor (CMOS) technology emphasized. VLSI Computer Aided Design (CAD) tools and CMOS layout rules and techniques. Project oriented. No student may earn credit for both 4833 and 5833. (F)
- ECE 4853 Biomedical Signals and Systems 3 Credit Hours**  
(Slashlisted with ECE 5853) Prerequisite: ECE 3723 and ECE 3793, or equivalent courses in electrical circuits and signal processing, or permission of instructor. Comprehensive coverage of topics related to signals in humans. Emphasis on using engineering tools to interpret signals and underlying physiological principles. Focus on emerging engineering technologies, physiological knowledge and clinical application. No student may earn credit for both 4853 and 5853. (Sp)
- ECE 4863 Bioinstrumentation 3 Credit Hours**  
(Slashlisted with ECE 5863) Prerequisite: ECE 3723 or ECE 4813 or permission of instructor. A comprehensive coverage of topics related to principles, applications and design of medical instruments widely used in hospitals and clinical research. Emphasis is placed on general design concepts, discussions on a great variety of medical devices and medical device safety issues. Materials cover different levels and various aspects of human systems, such as heart, brain, circulation, respiration and so on. Reading projects cover the state-of-the-art developments in advanced medical devices. No student may earn credit for both 4863 and 5863. (F, Sp)
- ECE 4960 Directed Readings 1-4 Credit Hours**  
1 to 4 hours. Prerequisite: good standing in University; permission of instructor and dean. May be repeated; maximum credit four hours. Designed for upper-division students who need opportunity to study a specific problem in greater depth than formal course content permits. (Irreg.)
- ECE 4970 Special Topics/Seminar 1-3 Credit Hours**  
1 to 3 hours. Prerequisite: Senior standing or permission of instructor. May be repeated; maximum credit nine hours. Special topics or seminar course for content not currently offered in regularly scheduled courses. May include library and/or laboratory research and field projects. (Irreg.)
- ECE 4973 Special Topics 3 Credit Hours**  
Prerequisite: Varies with course content. May be repeated with change of subject; maximum credit six hours in combination with 4990. Devoted to special topics in Electrical and Computer Engineering not covered in the current curriculum. (F, Sp, Su)
- ECE 4990 Special Studies 1-3 Credit Hours**  
Prerequisite: Senior standing and permission. May be repeated with change of subject matter; maximum credit six hours in combination with 4973. Devoted to supervised individual studies of special topics (S/U Graded) in Electrical and Computer Engineering. (F, Sp, Su)
- ECE 5123 Wireless Communications 3 Credit Hours**  
(Crosslisted with TCOM 5123) Prerequisite: 3793 or permission. Wireless communications principles, multiple access techniques, wireless networking, and systems and standards. (F)
- ECE 5153 Emerging Topics in LTE-Advanced and 5G 3 Credit Hours**  
(Crosslisted with TCOM 5153) Prerequisite: graduate standing. This course will train students to master the latest developments in the rapidly evolving landscape in wireless cellular networks, thereby preparing them for working on emerging as well as near future wireless technologies. Focuses on selected topics for research and development of LTE-A and 5G cellular networks. These topics include: PHY and MAC layer techniques suitable LTE-A & 5G; network densification techniques such as HetNets and C-RAN; Self Organizing Networks (SON); and Big Data Empowered SON. (Sp)
- ECE 5183 Quantum Information Theory 3 Credit Hours**  
(Crosslisted with TCOM 5183) Prerequisite: linear algebra. Introductory course of quantum information theory. Topics covered include quantum state, quantum measurement, quantum channels, No-Cloning Theorem, Bell's inequalities, entanglement, quantum dense coding, quantum teleportation, distance measures, quantum entropy, quantum mutual information, information of quantum channels. (F)
- ECE 5213 Digital Signal Processing 3 Credit Hours**  
(Slashlisted with 4213) Prerequisite: 3793. Discrete-time linear systems, finite duration impulse response digital filters, infinite impulse response digital filters, finite word length effects, spectral analysis, fast Fourier-transforms, two-dimensional signal processing and applications. No student may earn credit for both 4213 and 5213. (F)
- ECE 5223 Estimation and Identification 3 Credit Hours**  
Prerequisite: 5403 and 5523. Estimation and filtering, optimal filtering, modeling, parametric and nonparametric identification methods. (Sp)
- ECE 5253 Digital Systems Interfaces 3 Credit Hours**  
Prerequisite: 3223. Provides formal background in asynchronous sequential circuit design (fundamental mode circuits, races, hazards and pulse mode design), followed by a treatment of standard interface conventions for data transmission and reception and a discussion of priority interrupt systems. Finally, the use of A/D and D/A converters is presented. (Sp)

- ECE 5273 Digital Image Processing 3 Credit Hours**  
Prerequisite: 3793 or permission of instructor. This course covers the theory, methods, and applications of image enhancement, image restoration, image compression, image segmentation, image representation and description, and image recognition and interpretation. (Sp)
- ECE 5283 Special Topics in Digital Signal/Image Processing 3 Credit Hours**  
Prerequisite: 4213/5213 or 5273 or permission. May be repeated with change of content; maximum credit 12 hours. Selected topics in current research interest not covered by regularly scheduled course work. (Irreg.)
- ECE 5303 Solid State Electronics I 3 Credit Hours**  
Prerequisite: 3323. Principles and applications of electronic properties of solids for devices with particular emphasis on semiconductor junction, bulk and field effect devices. (F)
- ECE 5313 Semiconductor Material & Device Characterization 3 Credit Hours**  
Prerequisite: 3323. Characterization techniques and underlying principles for measuring semiconductor materials and devices. (Sp)
- ECE 5323 Opto-Electronics I 3 Credit Hours**  
Prerequisite: 3323 or Engineering 2313. Introduction to phenomenological and quantum mechanical theory of solids; introduction to lasers and masers with particular emphasis on the physical mechanisms underlying interactions between electromagnetic radiation and atomic systems. (F, Sp)
- ECE 5343 Quantum Structures and Devices 3 Credit Hours**  
Prerequisite: ECE 3323 or permission of instructor. Theory and application of KP method, strain effects, electrical and optical properties of quantum structures, semiconductor quantum devices including quantum well infrared photodetectors, quantum cascade and interband cascade lasers, type-II superlattice detectors. (Sp)
- ECE 5363 Optical Engineering 3 Credit Hours**  
(Slashlisted with 4363; Crosslisted with BME 5363) Prerequisite: ECE 3793. Underlying theory and design of optical systems. Interference, diffraction, and coherence phenomena will be examined as a basis for studying the limits of optical system performance. Other topics include a detailed study of polarization, the interaction of light with various media, and geometrical optics. No student may earn credit for both 4363 and 5363. (Sp)
- ECE 5383 IC Fabrication Technology I 3 Credit Hours**  
(Slashlisted with ECE 4383) Prerequisite: 3323. A treatment of the theory and processes involved in the fabrication of integrated circuits. No student may earn credit for both 4383 and 5383. (F)
- ECE 5393 Integrated Circuit Fabrication Technology II 3 Credit Hours**  
(Slashlisted ECE 4393) Prerequisite: ECE 5383. Students will gain hands-on experiences of cleanroom technologies of the semiconductor industry, including epitaxial crystal growth, photolithography, and some techniques such as SEM. No student may earn credit for both 4393 and 5393. (Sp)
- ECE 5403 Linear Systems Analysis 3 Credit Hours**  
Prerequisite: Math 3333. In-depth background course in methods of linear analysis in systems engineering. Topics include least squares methods, singular value decomposition, continuous and discrete time linear dynamical systems, controllability and state transfer. (F)
- ECE 5413 Control Theory 3 Credit Hours**  
Prerequisite: 4413, 5403. Controllability, optimal control and dynamic programming, LQR, observability, linear estimation and Kalman filter, realization theory. (Sp)
- ECE 5433 Measurement and Automation 3 Credit Hours**  
(Slashlisted with ECE 4433) Prerequisite: graduate standing, ENGR 3723 or Math Numerical Methods, ECE 3793 or instructor permission or systems course in another major. Fundamentals of data acquisition and control. A series of design projects in data acquisition, logging and real-time analysis. Includes machine vision and image processing as well as vibration, motion and real-time control. No student may earn credit for both 4433 and 5433. (F)
- ECE 5463 Advanced Computer Architecture 3 Credit Hours**  
(Crosslisted with C S 5463) Prerequisite: graduate standing. The design of modern programmable computer systems with emphases on exploiting parallelism at all levels, designing within constraints including energy consumption, and the impact of architecture on software design. Covers state of the art computer architecture, case studies and trends. (Sp)
- ECE 5513 Communication Theory 3 Credit Hours**  
Prerequisite: 4523. Probability theory, stochastic processes, detection, extraction and predictions of signals in noise. (F)
- ECE 5523 Random Signals 3 Credit Hours**  
Prerequisite: Graduate standing, ECE 2523, ECE 3793, or permission of instructor. This course explores random signals from two perspectives: random variables and random processes. Topics include probability, single and double random variables, and random vectors; concepts of stationarity and ergodicity; random signals as an input into linear systems and the statistical properties of their outputs; random signal parameters; and quality of estimators. (F)
- ECE 5533 Telecommunications Industry Overview 3 Credit Hours**  
Prerequisite: 3793. Studies the development of telecommunications technology, industry, and policy in the United States, stressing inter-relationships among industry, government bodies and policies, and users. Provides a broad view of telecommunications and of the direction of the industry. (F)
- ECE 5543 Telecom Network Design and Management 3 Credit Hours**  
Prerequisite: 3793. Introduction to basic issues in the design and management of telecommunications networks; Concepts will include those pertinent to telecommunications engineering and electrical and computer engineering, such as wide area network design principles that cater to Erlangian traffic. (Sp)
- ECE 5553 Telecommunications Technology 3 Credit Hours**  
Prerequisite: 3793. The ways and means by which voice, data and video traffic are moved long distances. Topics include data networks, telephone systems, video, and optical systems. (F)
- ECE 5563 Computer and Communications Security 3 Credit Hours**  
(Crosslisted with TCOM 5563) Prerequisite: 3793. Introduction to security problems in computing and communications basic encryption and decryption techniques, secure encryption systems, cryptographic protocols and practices, security in networks and distributed systems, legal and ethical issues in computer security. (Sp)
- ECE 5583 Information Theory 3 Credit Hours**  
Prerequisite: 4523 or equivalent. Introductory course in information theory. Topics include: asymptotic equipartition property, entropy, Fano's inequality, Huffman coding, lossy source coding theory, and channel coding theory. (F)

- ECE 5623 Computer Hardware Design 3 Credit Hours**  
(Slashlisted with 4623) Prerequisite: 3223. Design of modern digital computing circuits, computer arithmetic, number systems, state machines, control units, data transfer, bus interfacing, VHDL language elements and usage, circuit simulation. No student may earn credit for both 4623 and 5623. (F)
- ECE 5643 Radio Frequency and Microwave Engineering 3 Credit Hours**  
(Slashlisted with ECE 4643) Prerequisite: ECE 3613 and ECE 3713. Analysis of radio frequency (RF) and microwave components, circuits and systems using modern engineering tools and measurement instruments. No student may earn credit for both 4643 and 5643. (Sp)
- ECE 5653 Digital Radar Systems 3 Credit Hours**  
(Slashlisted with ECE 4653). Prerequisite: ECE 3793. Modern and next-generation radar systems, with an emphasis on the digital receiver and post processing that follows the RF front-end. Several off-the-shelf receiver case studies will be conducted. These will focus on analog-to-digital converter (ADC) selection followed by software defined radio (SDR) concepts for field programmable gate array (FPGA) implementation. These receivers may also be used for communication systems and have other broad applications. No student may earn credit for both 4653 and 5653. (F)
- ECE 5663 Radar Engineering 3 Credit Hours**  
(Crosslisted with METR 5663; Slashlisted with 4663) Prerequisite: Grade of C or better in 3613, or permission of instructor. Introduction to radar system designs and applications with emphasis on weather radar; radar system architecture and their functionalities and limitations of subsystems; theories of radar detection and estimation in a noisy and cluttered environment; existing technologies and advanced techniques to improve radar performance. No student may earn credit in both 4663 and 5663. (F)
- ECE 5673 Weather Radar Theory and Practice 3 Credit Hours**  
(Slashlisted with 4673, Crosslisted with METR 5673) Prerequisite: graduate standing, grade of C or better in Math 3113 and Physics 2524, or permission of instructor. Introduction to electromagnetic waves and propagation through the atmosphere, radar design trade-offs, antennas, transmitters, and coherent receivers; analysis of radar signals as noise-corrupted stochastic processes, with emphasis on digital signal processing for Doppler spectrum and moment estimation; implementation of processing algorithms using actual Doppler radar data. No student may earn credit for both 4673 and 5673. (F)
- ECE 5683 Weather Radar Applications 3 Credit Hours**  
(Crosslisted with METR 5683) Prerequisite: graduate standing in Meteorology or Engineering, or permission of instructor. Interpretation of meteorological structures using weather radar. Introduces scatter from hydrometeors and refractive index variations. Presentation of quantitative precipitation estimation methods based on the radar reflectivity factor, attenuation, and dual-polarization observations. Also includes the fundamental concepts of clear-air echoes and the estimation of winds under non-precipitation conditions. (Sp)
- ECE 5693 Antennas 3 Credit Hours**  
(Slashlisted with ECE 4693) Prerequisites: ECE 3613, ECE 4703, and permission of instructor. Introduction to antenna theory and design. Course covers design, construction, and measurement of antennas including, but not limited to the following specific types; dipoles, loops, aperture, microstrip, and broadband antennas, as well as array theory. No student may earn credit for both 4693 and 5693. (Sp)
- ECE 5703 Electromagnetic Fields and Wave Propagation 3 Credit Hours**  
(Slashlisted with ECE 4703) Prerequisite: ECE 3613. Maxwell's Equations, time-harmonic fields, plane waves, reflections on interfaces, waveguides and transmission lines, radiation, and antenna basics. No student may earn credit for both 4703 and 5703. (F, Sp)
- ECE 5713 Microwave Systems and Components 3 Credit Hours**  
Prerequisites: ECE 4643 or ECE 4693 or instructor permission. Theoretical and practical survey of modern high-frequency and microwave system engineering principles, active and passive microwave components, modern communication and radar systems. Laboratory- and project-based activities emphasize practical issues that arise in this area of engineering. (Fa)
- ECE 5723 Radar Signal Processing 3 Credit Hours**  
Prerequisite: ECE 3793 or equivalent. Radar fundamentals: radar range equation, waveforms, detection and matched filtering, ambiguity functions. Processing and Applications: Pulse-Doppler radar, synthetic aperture radar (SAR), moving target indication (MTI), space time adaptive processing (STAP). (Sp)
- ECE 5733 RF & Microwave Filter Design 3 Credit Hours**  
(Slashlisted with ECE 4733) Prerequisite: instructor permission. Introduction to advanced filter design. The use of filters is very widespread in all aspects of communication and radar systems. At the end of the semester, a student that has successfully embraced the subject will be able to design, fabricate, and test filters, using a range of different technologies and methods. No student may receive credit for both 4733 and 5733. (Sp)
- ECE 5833 VLSI Digital System Design 3 Credit Hours**  
(Slashlisted with ECE 4833) Prerequisite: ECE 3223 and ECE 3873. An introduction to Very-Large-Scale Integrated (VLSI) systems design methods; complementary Metal-Oxide Semiconductor (CMOS) technology emphasized. VLSI Computer Aided Design (CAD) tools and CMOS layout rules and techniques. Project oriented. No student may earn credit for both 4833 and 5833. (F)
- ECE 5843 Medical Imaging Systems 3 Credit Hours**  
Prerequisite: 3793 or Fourier transforms, or permission. Fundamental principles of medical image formation, image acquisition and image quality evaluation, Major medical imaging modalities, such as radiography, fluoroscopy, computed tomography, ultrasound, MRI, and nuclear medicine will be introduced. Clinical applications and limitations of each modality will also be analyzed. (Sp)
- ECE 5853 Biomedical Signals and Systems 3 Credit Hours**  
(Slashlisted with 4853, Crosslisted with BME 5853) Prerequisites: ECE 3723 and ECE 3793, or equivalent course in electrical circuits and signal processing, or permission of instructor. Comprehensive coverage of topics related to signals in humans. Emphasis on using engineering tools to interpret signals and underlying physiological principles. Focus on emerging engineering technologies, physiological knowledge and clinical application. No student may earn credit for both 4853 and 5853. (Sp)
- ECE 5863 Bioinstrumentation 3 Credit Hours**  
(Slashlisted with ECE 4863) Prerequisites: ECE 3773 or ECE 4813 or permission of instructor. A comprehensive coverage of topics related to principles, applications and design of medical instruments widely used in hospitals and clinical research. Emphasis is placed on general design concepts, discussions on a great variety of medical devices and medical device safety issues. Materials cover different levels and various aspects of human systems, such as heart, brain, circulation, respiration and so forth. The course will also provide reading projects to cover the state-of-the-art developments in advanced medical devices. No student may earn credit for both 4863 and 5863. (F, Sp)

**ECE 5873 Advanced VLSI Design and Applications 3 Credit Hours**

Prerequisite: ECE 4833 or ECE 5833. Design of sophisticated digital integrated circuits; special purpose architectures used where appropriate; silicon compiler and hardware description language used; project oriented. (Sp)

**ECE 5880 Professional Internship 1-3 Credit Hours**

1 to 3 hours. Prerequisite: graduate standing and 12 credit hours toward graduate degree. May be repeated; maximum credit six hours; grade equivalent to B or better required. Professional technical internship training in electrical and computer engineering, as part of M.S. or PhD degree requirements. A written report to be graded by a member of the graduate faculty is required. (F, Sp, Su)

**ECE 5960 Directed Readings 1-3 Credit Hours**

1 to 3 hours. Prerequisite: graduate standing and permission of department. May be repeated; maximum credit twelve hours. Directed readings and/or literature reviews under the direction of a faculty member. (F, Sp, Su)

**ECE 5970 Special Topics/Seminar 1-3 Credit Hours**

1 to 3 hours. Prerequisite: Graduate standing or permission of instructor. May be repeated; maximum credit nine hours. Special topics or seminar course for content not currently offered in regularly scheduled courses. May include library and/or laboratory research and field projects. (Irreg.)

**ECE 5973 Special Topics in Electrical and Computer Engineering 3 Credit Hours**

Prerequisite: permission of instructor. May be repeated with change of content; maximum credit 12 hours. Selected topics of current research interest not covered by regularly scheduled coursework. (F, Sp, Su)

**ECE 5980 Research for Master's Thesis 2-9 Credit Hours**

Variable enrollment, permission of instructor required, two to nine hours; credit required for degree, six hours. (F, Sp, Su)

**ECE 5990 Special Studies 1-3 Credit Hours**

1 to 3 hours. Prerequisite: graduate standing or permission. May be repeated with change of subject matter; maximum credit nine hours. Devoted to special topics in electrical engineering not covered in the regular curriculum or to supervised individual study. (F, Sp, Su)

**ECE 6213 Optical Information Processing 3 Credit Hours**

(Crosslisted with BME 6213) Prerequisite: ECE 5213 and ECE 5353. Application of Fourier transforms, linear systems, and diffraction theory to the analysis of optical systems. Emphasis is on the use of optical systems for information processing, including image enhancement, pattern recognition, data processing, optical switching, and computing. (F)

**ECE 6613 Weather Radar Polarimetry 3 Credit Hours**

(Crosslisted with METR 6613) Prerequisite: graduate standing. Provides fundamentals and principles of weather radar polarimetry through understanding wave scattering and propagation in geophysical media subject to turbulent mixing and filled with hydrometers and other objects. The relations between polarimetric radar observables and physical parameters will be established. The methods and algorithms for retrieving cloud and precipitation microphysics for weather quantification and forecast will be introduced. (F)

**ECE 6813 Advanced Topics in Biomedical Engineering 3 Credit Hours**

Prerequisite: 5843. May be repeated with change of content; maximum credit 12 hours. In-depth studies in biomedical engineering. Focus will be on advanced optoelectronic biomedical technologies, such as bioinstrumentation, biomedical imaging modalities. Students will learn the knowledge behind current technology and also research and development methods of applying future technology to clinical and biomedical applications. (Sp)

**ECE 6950 Research in Electrical and Computer Engineering 1-4 Credit Hours**

1 to 4 hours. Prerequisite: graduate standing and permission of instructor in Electrical and Computer Engineering. May be repeated; maximum credit 24 hours. Research in electrical and computer engineering occurring prior to the General Examination. (F, Sp, Su)

**ECE 6960 Directed Readings 1-3 Credit Hours**

1 to 3 hours. Prerequisite: graduate standing or permission of instructor. May be repeated; maximum credit six hours. Directed readings and/or literature review under the direction of a faculty member. (Irreg.)

**ECE 6970 Special Topics/Seminar 1-3 Credit Hours**

1 to 3 hours. Prerequisite: graduate standing or permission of instructor. May be repeated; maximum credit 12 hours. Special topics or seminar course for content not currently offered in regularly scheduled courses. May include library and/or research and field projects. (Irreg.)

**ECE 6973 Advanced Topics in Electrical and Computer Engineering 3 Credit Hours**

Prerequisite: permission of instructor. May be repeated with change of content; maximum credit 12 hours. Selected topics of current faculty research interest at the Ph.D. level not covered by regularly scheduled coursework. (Irreg.)

**ECE 6980 Research for Doctoral Dissertation 2-16 Credit Hours**

Prerequisite: Graduate standing. Permission of Instructor required. Research in Electrical and Computer Engineering. (F, Sp, Su)

**ECE 6990 Independent Study 1-3 Credit Hours**

1 to 3 hours. Prerequisite: Graduate standing and permission of instructor. May be repeated; maximum credit nine hours. Contracted independent study for a topic not currently offered in regularly scheduled courses. Independent study may include library and/or laboratory research and field projects. (Irreg.)