M.S. in Electrical Engineering

Candidates must satisfy a total of 30 credit hours (CH) with a minimum G.P.A. of 3.000 on a 4.000 scale.

All students must complete 12 credit hours (CH) of the core curriculum from one of the tracks below.

Communications and Networking

EE 7351 Power System Operation and Electricity Markets

An overview of power generation systems, economic operation of power systems, and electricity market operation. Introduces mathematical optimization methods used to solve practical problems in power system operation addressing economic and technical aspects of power generation and transmission. Topics include power generation characteristics; economic dispatch; unit commitment and proposed solution methodologies; the effect of transmission systems on unit commitment and economic dispatch of power systems; restructuring in power systems; power pools and bilateral contracts; pricing in electricity markets; day-ahead, real-time, and ancillary service markets; financial transmission rights; competition between market participants; congestion management; and demand response.

EE 7353 Power System Planning

Overview of power system planning, including basics of restructuring in power systems, reliability analysis in power systems, long-term demand forecast, power system production simulation, introduction to stochastic programming, midterm maintenance scheduling, mathematical model for generation expansion planning, transmission expansion planning, coordinated expansion planning, and other practices, such as transmission switching and demand response, which affect the expansion planning. *Prerequisite:* EE 5352/7352, EE 3352, or permission of instructor.

EE 7370 Communication and Information Systems

An introduction to communication and modulation systems in discrete and continuous time, the information content of signals, and the transitions of signals in the presence of noise. Amplitude, frequency, phase, and pulse modulation. Time and frequency division multiplex. *Prerequisite:* EE 3372.

EE 7375 Random Processes in Engineering

An introduction to probability and stochastic processes as used in communication and control. Topics include probability theory, random variables, expected values and moments, multivariate Gaussian distributions, stochastic processes, autocorrelation and power spectral densities, and an introduction to estimation and queuing theory. *Prerequisite*: Permission of the instructor.

EE 7376 Introduction to Computer Networks

This is an introductory course that surveys basic topics in communication networks with an emphasis on layered protocols and their design. Topics include OSI protocol reference model, data link protocols, local area networks, routing, congestion control, network management, security, and transport layer protocols. Network technologies include telephony, cellular, Ethernet, IP (Internet protocol), TCP, and ATM. Assignments may include lab exercises involving computer simulations.

EE 7377 Embedded Wireless Design Laboratory

A wide variety of real-world experiences in wireless communications networking using FPGAs equipped with embedded microprocessors. Covers basic wireless concepts of scheduled and random access as well as modulation and power control via labs that enable implementation of cellular and 802.11-based wireless protocols such as TDMA, Aloha, CSMA, and CSMA/CA. Also, broader topics that range from embedded programming, interrupt-driven operation, and FPGA-based design are covered in some depth. In a course project, student teams design novel wireless protocols and carry out experiments to measure the performance. *Prerequisite*: C- or better in EE 3360 or equivalent, or permission of the instructor.

EE 7378 Mobile Phone Embedded Design

In this course, students learn how to develop embedded software for the most widely used smartphone platforms with an emphasis on wireless and sensing applications. Topics include user interface design such as multi-touch and basic HCI design tenets, storing and fetching data with local networked systems and databases, localization via GPS and wireless signal triangulation, sensing environmental and user characteristics, networking with various wireless protocols, graphics rendering, multimedia streaming, and designing for performance such as controlling memory leaks, object allocation, and multi-threading. Content from the course draws from various fields including wireless communications and networking, embedded programming, and computer architecture.

EE 7379 Optimization in Wireless Networks

Covers a wide variety of optimization problems in the design and operation of wireless networks. Introduces basic linear programming and integer linear programming concepts and explains these concepts using examples from wired and wireless networks. Also, the basic structure and design of various wireless networks, including cellular networks (such as GSM) and wireless LANs (e.g., those based on 802.11g/n). *Prerequisite*: EE 2170 or equivalent, or permission of the instructor.

EE 8368 Signal Processing for Wireless Communications

This course focuses on signal processing used in wireless communications. Emphasis is given to channel equalization, which can be considered a form of temporal signal processing, spatial array processing, and space-time processing. Specific topics include classical and blind channel equalization, Fourier, parametric, and subspaced-based direction finding methods for smart antennas, and space-time signal processing. *Prerequisite*: EE 7372.

EE 8370 Analog and Digital Communications

Review of stochastic processes. Detection of waveform in noise. Matched filters and correlation receivers. Parameter and waveform estimation. Wiener and Kalman filters. Optimal receivers for analog and digital communication systems. *Prerequisite*: EE 7375.

EE 8371 Information Theory

An investigation of the fundamental performance limits of communication systems. Developments and proofs of Shannon's three theorems, involving channel capacity, lossless source coding and rate distortion theory. Includes entropy, entropy rate, mutual information, discrete memoryless channels and sources, and the additive white Gaussian noise channel. *Prerequisites*: EE 7370 and EE 7375.

EE 8372 (CSE 8352) Cryptography and Data Security

Cryptography is the study of mathematical systems for solving two kinds of security problems on public channels: privacy and authentication. Covers the theory and practice of both classical and modern cryptographic systems. The fundamental issues involved in the analysis and design of a modern cryptographic system will be identified or studied. *Prerequisite*: EE/STAT/CSE 4340 or equivalent.

EE 8375 Error Control Coding

Topics include information theory, algebraic and arithmetic codes and applications to computer systems. *Prerequisite*: Elementary probability concepts and digital logic circuits.

EE 8376 Detection and Estimation Theory

Advanced topics in detection and estimation, including asymptotic detector and estimator performance, robust detection, and nonparametric detection techniques. *Prerequisite*: EE 8370.

EE 8377 Advanced Digital Communications

Quantization, binary, and block encoding signals and systems, convolution coding, fading, diversity, spread-spectrum communications, mobile radio, and packet-radio communications. *Prerequisite*: EE 8370.

EE 8378 Performance Modeling and Evaluation of Computer Networks

This course applies probabilistic modeling and evaluation techniques to understanding the behavior of traffic, switching, and network protocols. Topics include basic queuing theory, traffic models, multiplexing, scheduling, switch models, routing, and traffic controls, in the context of protocols such as TCP/IP and ATM. *Prerequisites*: Probability, random processes and some knowledge of networks. EE 5376/7376 and CSE 6344.

Signal Processing and Control

EE 7345 Medical Signal Analysis

This course looks at the analysis of discrete-time medical signals and images. Topics include the design of discrete-time filters, medical imaging and tomography, signal and image compression, and spectrum estimation. The course project explores the application of these techniques to actual medical data. Research element required for course project.

EE 7352 Power System Analysis

Provides an overview of the power systems, including complex power calculation; theory of balanced three-phase circuits; per-unit system; transmission line characteristics for short, medium, and long lines; power flow analysis; three-phase balance fault; unbalanced fault and sequence impendences; and transient stability analysis in power systems. *Prerequisites:* Basic knowledge of electric power systems, fundamentals of electric power engineering (EE 3352) or equivalent.

EE 7360 Analog and Digital Control Systems

Feedback control of linear continuous systems in the time domain and frequency domain. Topics include plant representation, frequency response, stability, root locus, linear state variable feedback, and design of compensators. *Prerequisite*: EE 3372.

EE 7362 (ME 7302) Systems Analysis

State space representation of continuous and discrete-time systems, controllability, observability, and minimal representations; linear state variable feedback, observers, and quadratic regulator theory. *Prerequisite*: EE 3372.

EE 7371 Analog and Digital Filter Design

Approximation and analog design of Butterworth, Chebyshey, and Bessel filters. Basic frequency transformations for designing low-pass, band-pass, band-reject, and high-pass filters. Concepts of IIR digital filters using impulse-invariant and bilinear transformations. Design of FIR digital filters using frequency sampling and window methods. Canonical realization of IIR and FIR digital filters. Wave digital filters. Introduction to two-dimensional filters. *Prerequisite*: EE 5572.

EE 7372 Topics in Digital Signal Processing

This course is intended to provide an extended coverage of processing of discrete-time signals. Discrete-time signals and the analysis of systems in both the time and frequency domains are reviewed. Other topics covered will include multi-rate signal processing, digital filter structures, filter design and power spectral estimation. *Prerequisite*: C- or better in EE 3372.

EE 7373 DSP Programming Laboratory

This course looks at applications of digital signal processor technology based on the Texas Instruments TMS320C50 DSP. The course looks at DSP device architecture, assembly language, use of DSP development tools, design of FIR and IIR filters, and real-time spectrum analysis with the FFT.

EE 7374 Digital Image Processing

Provides an introduction to the basic concepts and techniques of digital image processing. Topics covered will include characterization and representation of images, image enhancement, image restoration, image analysis, image coding, and reconstruction. *Prerequisite*: EE 7372.

EE 7375 Random Processes in Engineering

An introduction to probability and stochastic processes as used in communication and control. Topics include probability theory, random variables, expected values and moments, multivariate Gaussian distributions, stochastic processes, autocorrelation and power spectral densities, and an introduction to estimation and queuing theory. *Prerequisite*: Permission of the instructor.

EE 8364 Statistical Pattern Recognition

Introduction to various parametric and nonparametric statistical approaches to automatic classification of a set of processes. Topics include Bayes, Neyman-Pearson, Minimas, sequential, and nearest-neighbor classifiers, estimation of classifier error, parameter estimation, density function estimation, linear discriminant functions, feature selection and evaluation, unsupervised recognition techniques and clustering analysis.
Prerequisite: EE 7375 or equivalent.

EE 8365 Adaptive Filters

A detailed treatment of the theory and application of adaptive filter processing. Topics include linear prediction, stochastic gradient (LMS) adaptive transversal filters, recursive least-squares (RLS) adaptive transversal filters, lattice filters, and fast RLS algorithms. Applications to be discussed include adaptive equalization, echo cancellation, system identification, beamforming, speech coding, and spectral estimation.
Prerequisite: EE 7372, EE 7375, or permission of the instructor.

EE 8367 (ME 8367) Nonlinear Control

This course introduces the student to methods of the control of nonlinear systems. The course reviews phase plane analysis of nonlinear systems, Lyapunov theory, nonlinear stability and describing function analysis. Advance control techniques include feedback linearization, sliding control, and adaptive control. Special emphasis will be placed on the application of the developed concepts to the robust regulation of the response of nonlinear systems. *Prerequisite*: EE 7362.

EE 8368 Signal Processing for Wireless Communications

This course focuses on signal processing used in wireless communications. Emphasis is given to channel equalization, which can be considered a form of temporal signal processing, spatial array processing, and space-time processing. Specific topics include classical and blind channel equalization, Fourier, parametric, and subspace-based direction finding methods for smart antennas and space-time signal processing. *Prerequisite*: EE 7372.

EE 8373 Digital Speech Processing

A detailed treatment of theory and application of digital speech processing. The course provides a fundamental knowledge of speech signals and speech processing techniques. Topics include digital speech coding, speech synthesis, speech recognition, and speech verification. *Prerequisite*: EE 7372.

EE 8374 Fundamentals of Computer Vision

Introduction to the basic concepts and various techniques for computer analysis, interpretation, and recognition of pictorial data. Topics include binary image analysis, edge and curve detection, image segmentation, shape and texture representation and recognition, morphological methods, and stereo vision. *Prerequisite*s: Familiarity with basic concepts in signal processing and probability theory.

EE 8376 Detection and Estimation Theory

Advanced topics in detection and estimation, including asymptotic detector and estimator performance, robust detection, and nonparametric detection techniques. *Prerequisite*: EE 8370.

EE 8382 Digital Signal Processing Architectures

Introduction to DSP systems; iteration bound; pipelining and parallel processing, retiming, unfolding, and folding; systolic architecture design; speed, power, computational, and memory resource design issues; case studies and design examples for FIR filters, IIR filters, and orthogonal transforms; and architectural overview of programmable digital signal processors. *Prerequisite:* EE 5372, equivalent knowledge of digital signal processing concepts, or permission of instructor.

Computer Engineering

EE 7321 Semiconductor Devices and Circuits

A study of the basics of CMOS integrated analog circuits design. Topics include MOSFET transistor characteristics, DC biasing, small-signal models, different amplifiers, current mirrors, single- and multi-stage electronic amplifiers, frequency response of electronic amplifiers, amplifiers with negative feedback and stability of amplifiers. Each student will complete one or more design projects by the end of the course. *Prerequisite*s: EE 3122 and EE 3322.

EE 7340 Biomedical Instrumentation

Application of engineering principles to solving problems encountered in biomedical research. Topics include transducer principles, electrophysiology, and cardiopulmonary measurement systems.

EE 7356 VLSI Design and Lab

Explores the design aspects involved in the realization of CMOS integrated circuits from device up to the register/subsystem level. Addresses major design methodologies with emphasis placed on structured, full-custom design. Also, the MOS device, CMOS inverter static characteristics, CMOS inverter dynamic characteristics, CMOS transistor fabrication technology, combination logic circuit, alternative static logic circuit, sequential logic circuit, dynamic logic circuit, propagation delay and interconnect, power dissipation and design for low power, memory device (DRAW/SRAM/ROM), ESD protection, packaging, testing and VLSI design flow. Students use state-of-the art CAD tools to verify designs and develop efficient circuit layouts.
*Prerequisite*s: C- or better in EE 2181, EE 2381, and EE 3311.

EE 7357 CAE Tools for Structured Digital Design

This course concentrates on the use of CAE tools for the design and stimulation of complex digital systems. Verilog, a registered trademark of Cadence Design Systems, Inc., hardware description language, will be discussed and use for behavioral and structural hardware modeling. Structured modeling and design will be emphasized. Design case studies include a pipeline processor, cache memory, UART, and a floppy disk controller.
Prerequisite: EE 2381 or permission of the instructor.

EE 7378 Mobile Phone Embedded Design

In this course, students learn how to develop embedded software for the most widely used smartphone platforms with an emphasis on wireless and sensing applications. Topics include user interface design such as multi-touch and basic HCI design tenets, storing and fetching data with local networked systems and databases, localization via GPS and wireless signal triangulation, sensing environmental and user characteristics, networking with various wireless protocols, graphics rendering, multimedia streaming, and designing for performance such as controlling memory leaks, object allocation, and multi-threading. Content from the course draws from various fields including wireless communications and networking, embedded programming, and computer architecture.

EE 7381 Digital Computer Design

Emphasizes design of digital systems and register transfer. Design conventions, addressing modes, interrupts, input-output, channel organization, high-speed arithmetic, hardwired and microprogrammed control. Central processor organization design and memory organization. Each student will complete one or more laboratory projects by the end of the course. *Prerequisites*: EE 2181 and EE 2381.

EE 7385 Microcontroller Architecture and Interfacing

Emphasizes the design and interfacing of microprocessor computer systems. Topics cover processor architecture and interfacing, memory structure and interfacing, bus systems, support chips, tools for hardware design, analysis, simulation, implementation, and debugging. The theoretical part of the course is complemented by a laboratory in which students get practical experience in designing and analyzing interfaces to processors, memories, and peripherals. *Prerequisite*: CSE 3381, or both EE 3181 and EE 3381.

EE 7387 Digital Systems Design

Modern topics in digital systems design, including the use of HDLs for circuit specification and automated synthesis tools for realization. Programmable logic devices are emphasized and used throughout the course. Includes heavy laboratory assignment content and a design project. *Prerequisite:* EE 2381 or CSE 3381.

EE 8356 Advanced Topics in VLSI Design

This is a seminar-oriented course aiming at advanced issues in VLSI design. The instructor will make a short introduction for each topic covered. The students are then required to make a presentation on the details. The term project is required for each student. The grade will be based on both presentation and project. *Prerequisite*: EE 7356 or permission of the instructor.

EE 8382 Digital Signal Processing Architectures

Introduction to DSP Systems. Iteration bound. Pipelining and parallel processing; retiming; unfolding and folding. Systolic architecture design. Speed, power, computational, and memory resource design issues. Case studies and design examples for FIR filters, IIR filters, and orthogonal transforms. Architectural overview of programmable digital signal processors. *Prerequisite*: EE 5372, equivalent knowledge of digital signal processing concepts, or permission of the instructor.

EE 8386 (CSE 8386) Testing of VLSI Circuits

The objective of testing is to verify that the manufactured custom chips function correctly according to their specifications. Testing process includes fault modeling, mainly automated simulation, test pattern generation, and testable and self-testing design synthesizing. Structured chips such as memories, PLAs, and FPGAs are also tested for correctness. The course surveys the state-of-the-art test approaches used in industry and in other research environments. *Prerequisites:* Digital logic design, data structures, and algorithms.

Electromagnetics

EE 7330 Electromagnetics: Guided Waves

Application of Maxwell's equations to guided waves. Transmission lines, plane wave propagation and reflection. Hollow waveguides and dielectric waveguides. Fiber optics, cavity and dielectric resonators. *Prerequisite*: EE 3330.

EE 7332 (MATH 6360) Electromagnetics: Radiation and Antennas

Polarization, reflection, refraction, and diffraction of EM waves. Dipole, loop and slot/reflector/antennas. Array analysis and synthesis. Self- and mutual impedance. Radiation resistance. *Prerequisite*: EE 3330.

EE 7333 Antennas and Radiowave Propagation for Personal Communications

This course is concerned with three important aspects of telecommunications: fixed site antennas, radiowave propagation, and small antennas proximate to the body. The topics include electromagnetics fundamentals; general definitions of antenna characteristics; electromagnetic theorems for antenna applications; various antennas for cellular communications including loop, dipole, and patch antennas; wave propagation characteristics as in earth-satellite communications, radio test sites, urban and suburban paths, and multipath propagation; and radio communication systems. *Prerequisite*: EE 3330.

EE 8331 Microwave Electronics

A study of microwave circuit design covering amplifiers, mixers and oscillators using s-parameters. Topics include scattering parameters, transmission lines, impedance matching, network synthesis, stability, noise, narrowband and broadband amplifier design, low-noise amplifiers, multistage amplifiers, biasing considerations, microwave oscillators, and microwave mixers. Relationships to CAE tools. *Prerequisite*: EE 3330, EE 7330, or EE 7332.

EE 8332 Numerical Techniques in Electromagnetics

This course introduces various numerical methods in electromagnetics, with emphasis on practical applications. The numerical methods include the moment method, finite difference method, and finite element method. *Prerequisites*: EE 7330 and proficiency in one computer language (e.g. FORTRAN) or permission of the instructor.

EE 8333 Advanced Electromagnetic Theory

The course offers the advanced level of electromagnetic theory beyond EE 5330. Topics include various electromagnetic theories and principles, Green's functions, and perturbational and variational techniques. *Prerequisite*: EE 7330.

Electronic Materials, Devices and Microelectronics

EE 7310 Introduction to Semiconductors

The basic principles in physics and chemistry of semiconductors that have direct applications on device operation and fabrication are studied. Topics include basic semiconductor properties, elements of quantum mechanics, energy band theory, equilibrium carrier statistics, carrier transport, and generation-recombination processes. These physical principles are applied to semiconductor devices. Devices studied include metal-semiconductor junctions, p-n junctions, LEDs, semiconductor lasers, bipolar junction transistors, field-effect transistors, and integrated circuits. The emphasis will be on obtaining the governing equations of device operation based on physical principles.

EE 7312 Compound Semiconductor Devices and Processing

This is a laboratory-oriented elective course for upper level undergraduates and graduate students providing in-depth coverage of processing of InP- and GaAs-based devices in addition to silicon integrated circuit processing. Students without fabrication experience will fabricate and characterize MOSFETS and semiconductor lasers. Students with some previous fabrication experience (such as EE 3311) will fabricate and test an advanced device mutually agreed upon by the student(s) and the instructor. Examples of such devices include High Electron Mobility Transistors (HEMTs), Heterojunction Bipolar Transistors (HBTs), phase shifters, distributed Bragg reflector (DBR) lasers, grating assisted directional couplers and semiconductor lasers from developing materials such as GaInNAs. The governing equations of photolithography, oxidation, diffusion, ion-implantation, metalization, and etching will be derived from fundamental concepts. Silicon process modeling will use the CAD tool SUPREM. Optical components will be modeled using the SMU developed software WAVEGUIDE, GAIN and GRATING. A laboratory report describing the projects will be peer-reviewed before final submission. *Prerequisite*: EE 3311 or equivalent.

EE 7314 (ME 7314) Introduction to Microelectromechanical Systems and Devices

This course develops the basics for microelectromechanical devices and systems, including microactuators, microsensors, micromotors, principles of operation, different micromachining techniques (surface and bulk micromachining), IC-derived microfabrication techniques, and thin-film technologies as they apply to MEMS.

EE 7321 Semiconductor Devices and Circuits

A study of the basics of CMOS integrated analog circuits design. Topics include MOSFET transistor characteristics, DC biasing, small-signal models, different amplifiers, current mirrors, single- and multi-stage electronic amplifiers, frequency response of electronic amplifiers, amplifiers with negative feedback and stability of amplifiers. Each student will complete one or more design projects by the end of the course. *Prerequisite*s: EE 3122 and EE 3322.

EE 7322 Semiconductor Devices and Fabrication

Laboratory-oriented elective course that introduces the working principles of semiconductor devices and includes the fabricating and testing of silicon MOSFET transistors in the SMU cleanroom. Lectures and class discussions (about 22 hours) explain the basic operation of p-n junction diodes, bipolar junction transistors, heterojunction bipolar transistors, field-effect transistors, high-electron mobility transistors, solar cells, detectors, light-emitting diodes, and semiconductor lasers. Class lectures (about 20 hours) cover the basics of device processing, including photolithography, oxidation, diffusion, ion-implantation, metallization, and etching. Weekly laboratory reports and a final project report describing the fabrication and testing of devices account for a major portion of the course grade. Students lead weekly discussions of the previous week's laboratory experiences and homework problems. An optional field trip to a local semiconductor related company is possible. Credit will not be given for both EE 7322 and EE 3311.

EE 7336 Introduction to Integrated Photonics

This course is directed at the issues of integrated photonics. Four major areas are covered: 1) fundamental principles of electromagnetic theory, 2) waveguides, 3) simulation of waveguide modes, and 4) photonic structures. The emphasis is slightly heavier into optical waveguides and numerical simulation techniques because advances in optical communications will be based on nanostructure waveguides coupled with new materials. Topics include Maxwell's equations; slab, step index, rectangular and graded index wave guides; dispersion; attenuations; non-linear effects; numerical methods; and coupled mode theory. Mathematical packages such as MATLAB and/or Mathematica will be used extensively in this class. *Prerequisite*s: EE 3311 and EE 3330 or permission of instructor.

EE 8322 Semiconductors Lasers

This course introduces various numerical methods in electromagnetics, with emphasis on practical applications. The numerical methods include the moment method, finite difference method, and finite element method. *Prerequisite*s: EE 7330 and proficiency in one computer language (e.g. FORTRAN) or permission of the instructor.

EE 8323 Lasers and Optics

Introduces lasers and photonics. Includes ray and beam optics, analysis and design of cavities and resonators, the interaction of light with matter, rate equations and pumping, power optimization, pulsed behavior, diode lasers, and topics in photonic integration. *Prerequisite:* EE 7330 or 7332, or equivalent.

EE 8331 Microwave Electronics

A study of microwave circuit design covering amplifiers, mixers, and oscillators using s-parameters. Topics include scattering parameters, transmission lines, impedance matching, network synthesis, stability, noise, narrowband and broadband amplifier design, low-noise amplifiers, multistage amplifiers, biasing considerations, microwave oscillators, microwave mixers, and relationships to CAE tools. *Prerequisite:* EE 3330, 7330, or 7332.

EE 8355 Transistor Integrated Circuits

An introduction to CMOS, BJT, and BiCMOS analog integrated circuits. Topics include development of detailed, physically based device model for SPICE simulation and application of these to components of operational amplifiers such as bias, differential, gain and output stages, frequency response and compensation and feedback circuits. Emphasis is on modern CMOS operational amplifier design with BiCMOS applications. As an extension of EE 7321, this course covers the topics in more depth and considers high frequency aspects of analog circuits.

The remaining courses may be taken from different tracks. Of these, two can be from outside the EE department. Non-EE courses are restricted to EETS (with the exception of EETS 7301 or EETS 7302), ME, CSE, EMIS, CEE, math, physics, statistics, chemistry, biology, geological sciences or business. At least two of the EE courses (six term credit hours) must be graduate courses numbered 8000. EETS courses do not count toward this requirement. An optional master's thesis may be substituted for two of the eight primary/secondary courses and count toward the 8000-level requirement. The student should file a degree plan of study with the help of his or her adviser as soon as possible after admission, but no later than the end of the second term after matriculation. Courses not listed on the degree plan of study should not be taken without the approval of the adviser. If the degree plan of study is altered, the student must go through the approval process again.