Department of

ELECTRICAL ENGINEERING (ELE)

Mohammad A. Karim,
Program Director

Electrical Engineering is a major concentration for both the Doctor of Philosophy in Engineering and the Doctor of Engineering. See Doctor's Degree Regulations in the introductory section of this chapter and consult with the department chair.

PROGRAM REQUIREMENTS

The program of study leading to the Master of Science in Electrical Engineering must include a minimum of 30 semester hours of credit consisting of the following.

1. Six semester hours in basic and engineering sciences. It is possible to combine six semester hours from separate areas. Selected courses must meet with the approvalof the advisor.
2. Nine hours in electrical engineering core courses selected from:
   - ELE 501. Introduction to Digital Systems
   - ELE 503. Random Processes
   - ELE 506. Solid State Devices
   - ELE 507. Electromagnetic Fields I
   - ELE 509. Analysis of Linear Systems
3. Nine hours in a specialization area approved by the advisor.
4. Six hours on an approved thesis or six hours of additional electrical engineering course work. Graduate Assistants must use the thesis option.

A qualifying exam may be required for acceptance into the program. A final examination is required at the completion of the program.

See also the Master's Degree Regulations in the introductory section of this chapter. Specific course requirements are listed in the Electrical Engineering department graduate brochure.

ELECTRICAL ENGINEERING COURSES OF INSTRUCTION

ELE 501. CONTEMPORARY DIGITAL SYSTEMS: Introduction to sequential logic; state machines; high performance digital systems: theory and application of modern design; alternative implementation forms and introduction to HDL; productivity, recurring and non-recurring costs, flexibility, and testability; software drivers; hardware/software integration. Prerequisite: ELE 235 or equivalent. *3 sem. hrs.*

ELE 503. RANDOM PROCESSES: An introduction to random variables and processes as applied to system theory, communications, signal processing and controls. Topics include probability, random variables and processes, autocorrelation, power spectral density and linear system theory with random inputs. Applications in filtering and estimation. Prerequisites: ELE 331 and ISE 369 or equivalent. *3 sem. hrs.*

ELE 506. SOLID STATE DEVICES: Introduction to the theory of solid state devices; energy band theory; bulk properties of semiconductors; p-n junction, bipolar junction transistor, metal-oxide semiconductor (MOS), MOS capacitor, MOS field-effect transistor-theory, devices, modeling and applications. Prerequisite: ELE 312 or equivalent. *3 sem. hrs.*

ELE 507. ELECTROMAGNETIC FIELDS I: Fundamental concepts, wave equation and its solutions; wave propagation, reflection and transmission; potential theory; construction of solutions; various electromagnetic theorems: concept of source, uniqueness, equivalence, induction and reciprocity theorems. Prerequisite: ELE 333 or equivalent. *3 sem. hrs.*

ELE 509. ANALYSIS OF LINEAR SYSTEMS: Signals, Systems, Orthogonal Decomposition, Fourier Analysis, Laplace Transforms, Z-Transforms, State Variables, and their application to the analysis of linear systems. *3 sem. hrs.*

ELE 510. MICROWAVE ENGINEERING: Microwave transmission, planar transmission lines, microwave components and filters. Microwave tubes, microwave communication, radar systems, and electronic support measures. Prerequisite: ELE 507. *3 sem. hrs.*

ELE 511. ANTENNAS AND RADIATION THEORY: Fundamental principles of antennas; analysis and synthesis of arrays; resonant antennas; broadband and frequency independent antennas; aperture and reflector antennas; applications to radar and communication systems. Prerequiste: ELE 442. *3 sem. hrs.*

ELE 518. ELECTROMAGNETIC FIELDS II: Classification and construction of solutions. Plane cylindrical and spherical wave functions. Integral equations, mathematical theory of diffraction. Green's function. Prerequisite: ELE 507. *3 sem. hrs.*

ELE 521. COMMUNICATION THEORY: Review of the fundamentals of analog and digital communications; analog and digital signal detection in the presence of Gaussian noise; multilevel signals; thresholding for minimizing error probability; comparison of performance in a high noise environment. Prerequisite: ELE 413 or equivalent, ELE 503. *3 sem. hrs.*

ELE 522. DIGITAL COMMUNICATION: Fundamentals of digital communications systems including coding and channel capacity; detection and estimation; comparative performance of systems; synchronous vs. asynchronous methods; system synchronization; error control coding. Prerequisite: ELE 521. *3 sem. hrs.*

ELE 523. SPREAD SPECTRUM SYSTEMS: Fundamentals of Spread Spectrum communication systems; direct sequence, pseudonoise, fre-

quency hopping, time hopping modulation techniques; signal detection techniques; comparative analysis; applications, Prerequistite: ELE 521. *3 sem. hrs.*

ELE 533. COMPUTER DESIGN: Design considerations of the computer; register transfer operations; hardware implementation of arithmetic processors and ALU; instruction set format and design and its effect on the internal microengine; hardware and microprogrammed control design; comparative architectures. Prerequisite: ELE 501 or equivalent. *3 sem. hrs.*

ELE 536. MICROPROCESSOR APPLICATIONS: Project studies, applications of microprocessors in practical implementations; logic implementation using software; memory mapped I/O problems and interrupt structure implementation; use of assembler and/or cross assemblers; study of alternate microprocessor families including industrial controllers. Prerequisites: ELE 314 or equivalent and ELE 501. *3 sem. hrs.*

ELE 541. POWER ELECTRONICS: Power switching devices including diodes, thyristors, triacs, BJTs, and MOSFETs. Power electronic converters, power amplification, power regulation and power conversion control. *3 sem. hrs.*

ELE 542. ELECTRICAL MACHINES AND CONTROL: Generalized analysis of electrical machines. Transient solution of nonlinear, time-varying machine equations. Reference frame theory. Induction machines. Brushless DC machines. Stepper motors. Control of ac and dc machines. Prerequisite: ELE 431 or equivalent. *3 sem. hrs.*

ELE 545. AUTOMATIC CONTROL: Analog and Digital Control System Design. Analysis and synthesis of feedback control systems. Performance and stability analysis. Regulator and servomechanism design: time and frequency domain methods. State-space methods: SVF design and observers. Digital implementation issues. Prerequisite: ELE 509. *3 sem. hrs.*

ELE 546. INSTRUMENTATION DESIGN: Theory of measurements: errors, accuracy, precision and bias. Analysis of measuring devices for various physical quantities such as motion, dimension, force, pressure and flow. Computer-aided experimentation. Automated data collection, recording, transmission and analysis. Virtual instrument design. *3 sem. hrs.*

ELE 551. ELECTRICAL POWER SYSTEMS DYNAMICS: Basic structure of the electrical power transmission system; criteria for system stability; symmetrical components; synchronous machine equations of motion, transients and dynamics; transmission line surges, short circuit calculations. Prerequisites: ELE 333, ELE 431. *3 sem. hrs.*

ELE 555. SYSTEMS DYNAMICS I: The methodolgoy for modeling the dynamics of complex social-economic systems. Use of these models to study organizational policies and design for higher-order, multiple-loop, nonlinear feedback structures. *3 sem. hrs.*

ELE 556. SYSTEMS DYNAMICS II: The continuation of Systems Dynamics I with special emphasis on the study of large-scale corporate, urban, educational, and ecological systems. Prerequisite: ELE 555. *3 sem. hrs.*

ELE 561. DIGITAL SIGNAL PROCESSING I: A study of one-dimensional digital signal processing including a review of continuous system analysis and sampling. Topics include z-transform techniques, digital filter design and analysis, and fast Fourier transform processing techniques. Prerequisite: ELE 509. *3 sem. hrs.*

ELE 562. DIGITAL SIGNAL PROCESSING II: A study of the architectural requirements for one-dimensional digital signal processing. This includes the techniques for the design of both hardware and software elements needed for implementation of digital signal processors as well as application of those processors. Prerequisite: ELE 561. *3 sem. hrs.*

ELE 563. IMAGE PROCESSING: An introduction to image processing including the human visual system, image formats, two-dimensional transforms, image restoration, and image reconstruction. Prerequisite: ELE 561. *3 sem. hrs.*

ELE 572. LINEAR SYSTEMS AND FOURIER OPTICS: Mathematical techniques pertaining to linear systems theory; Fresnel and Fraunhoffer diffraction; Fourier transform properties of lenses; frequency analysis of optical systems, spatial filtering, application such as optical information processing and holography. Prerequisite: Acceptance into the EE graduate program or permission of the department chairperson. *3 sem. hrs.*

ELE 573. ELECTRO-OPTICAL DEVICES & SYSTEMS: Solid-state theory of optoelectronic devices; photoemitters; photodetectors; solar cells; detection and noise; displays; electro-optic, magneto-optic, and acousto-optic modulators; integration and application of electro-optical components in electro-optical systems of various types. Prerequisite: ELE 507, or permission of the department chairperson. *3 sem. hrs.*

ELE 574. GUIDED-WAVE OPTICS: Light propagation in slab and cylindrical waveguides; signal degradation in optical fibers; optical sources, detectors, and receivers; coupling; transmission link analysis; fiber fabrication and cabling; fiber sensor system. Prerequisite: ELE 507 or permission of the department chairperson. *3 sem. hrs.*

ELE 575. ELECTRO-OPTICS SENSORS: Optical sensors, including amplitude, phase, wavelength, polarization and modal interference based sensors. Photoelasticity effects in stressed optical materials. Quadrature point stabilization, linearity, dynamic range and sensitivity. Modulation and demodulation by both passive and active means. General sensor characteristics. Optical sources and detectors, optical signal-to-noise ratio analysis and general sensor characteristics. Fiber optic sensors and smart skin/structure technology. Prerequisite: ELE 574 or permission of the department chairperson. *3 sem. hrs.*

ELE 577L. ELECTRO-OPTICS LABORATORY: Experimentation with E-O systems emphasizing areas such as display technology, surveilance systems and components, and other disciplines in which electronic and otpical elements are arranged to interact synergistically. *1 sem. hr.*

ELE 595. SPECIAL PROBLEMS IN ELECTRICAL ENGINEERING: Particular assignments to be arranged and approved by the department chairperson. *2-6 sem. hrs.*

ELE 599. THESIS: *3-6 SEM. HRS.*

ELE 603. APPLIED OPTIMAL ESTIMATION: Random processes and state-space analysis. Applied optimal estimation with emphasis on Kalman and Weiner filtering. Prerequisite: ELE 503, ELE 545 or equivalent. *3 sem. hrs.*

ELE 611. ADVANCED ANTENNA THEORY: Advanced topics in antennas including advanced arrays, antenna temperature, synthetic apertures, aperture antennas, microwave traveling wave antennas. Prerequisites: ELE 507 and ELE 511. *3 sem. hrs.*

ELE 612. METHODS IN RADAR CROSS SECTION: Solution of problems in radar cross section analysis and prediction. RCS of simple shapes and complex shapes. Reflection and transmission; impedance boundary condition, stratified media. RCS of antennas. Application of the physical theory of diffraction and the geometrical theory of diffraction to scattering problems. Prerequisites: ELE 507, ELE 511. *3 sem. hrs.*

ELE 615. COMPUTATIONAL ELECTROMAGNETICS: This course deals with both the differential equation and integral equation based methods to solve Maxwell's equations for complex bodies. Methods studied include the Moment Method, Finite Element Method, and Finite Difference Time Domain Method. The course also deals with asymptotic techniques leading to the formulation to the GTD and PTD. Prerequisites: ELE 507, ELE 518. *3 sem. hrs.*

ELE 631. MICROELECTRONICS SYSTEMS: Introduction to the design and application of engineering microelectronics; bipolar and MOS device theory and processing technology; CMOS logic and circuitry; design principles fundamental to chip design and fabrication; case studies employing introduction to HDL. Prerequisite: ELE 536. *3 sem. hrs.*

ELE 636. ADVANCED COMPUTER ARCHITECTURE: Comparative evaluation of advanced and experimental computer structures. Investigation of optical, multiprocessor, array, various hybrid and neural network architectures. This is an advanced seminar class using current computer design and experimental literature. Prerequisite: ELE 536. *3 sem. hrs.*

ELE 641. NONLINEAR CONTROL: A study of the major techniques of nonlinear system analysis including phase plane analysis, describing function analysis and Lyapunov Stability Theory. Application of the analytical techniques to control system design including feedback linearization, sliding mode control and an introduction to adaptive control. Prerequisites: ELE 509 and ELE 545. *3 sem. hrs.*

ELE 642. OPTIMAL CONTROL AND ESTIMATION: Optimal control of discrete-time systems. Cost-equivalent control of continuous-time systems. Optimal estimation. Prerequisites: ELE 517, ELE 545. *3 sem. hrs.*

ELE 661. STATISTICAL SIGNAL PROCESSING: This course studies discrete mehtods of linear estimation theory. Topics include random vector, linear transformations, linear estimation, optimal filtering, linear prediction, and spectrum estimation. Prerequisite: ELE 561. *3 sem. hrs.*

ELE 662. ADAPTIVE SIGNAL PROCESSING: An overview of the theory, design, and implementation of adaptive signal processors. This includes discussions of various gradient search techniques, filter structures, and applications. An introduction to neural networks is also included. Prerequisite: ELE 661. *3 sem. hrs.*

ELE 663. STATISTICAL PATTERN RECOGNITION: This course provides a comprehensive treatment of the statistical pattern recognition problem. The mathematical models describing these problems and the mathematical tools necessary for solving them are covered in detail. Prerequisite: ELE 661. *3 sem. hrs.*

ELE 674. INTEGRATED OPTICS: Review of electromagnetic principles; dielectric slab waveguides; cylindrical dielectric waveguides; dispersion, shifting and flattening; mode coupling and loss mechanism; selected nonlinear waveguiding effects; integrated optical devices. Prerequisite: ELE 574. *3 sem. hrs.*

ELE 676. QUANTUM ELECTRONICS: Principles of the quantum theory of electron and photon processes; inter action of electromagnetic radiation and matter; applications to solid state and semiconductor laser systems. Prerequisite: ELE 506, or EOP 506/ELE 573 or equivalent. *3 sem. hrs.*

ELE 690. SELECTED READINGS IN ELECTRICAL ENGINEEERING: Directed Readings in electrical engineering areas to be arranged and approved by the chair of the student's doctoral advisory committee and the department chairperson. *1-3 sem. hrs.*

ELE 695. SPECIAL PROBLEMS IN ELECTRICAL ENGINEERING: Special topics in electrical engineering not covered in regular courses. Course sections arranged and approved by the chair of the student's doctoral advisory committee and the department chairperson. *1-3 sem. hrs.*

ELE 698. D.E. DISSERTATION: An original investigation as applied to electrical engineering practice. Results must be sufficient importance to merit publication. *1-15 sem. hrs.*

ELE 699. Ph.D. DISSERTATION: An original research in electrical engineering which makes a definite contribution to technical knowledge. Results must be of sufficient importance to merit publication. *1-15 sem. hrs.*