### Electrical Engineering (EE)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester Hours</th>
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<tr>
<td>EE 501</td>
<td>DIGITAL SIGNAL PROC ARCHITECTU</td>
<td>3</td>
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<tr>
<td></td>
<td>Introduction to digital signal processor architecture, applications, assembly language programming, and development tools for designing and implementing DSP systems.</td>
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<td>EE 504</td>
<td>INTRO DATA COMMUNICA NETWORKS</td>
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<td>Overview of historic development of modern telephone and data communication system, system architecture, standards, broadband switching systems, modems, protocols, personal and mobile communications, digital modulation techniques.</td>
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<tr>
<td>EE 506</td>
<td>COMMUNICATION THEORY</td>
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<td>EE 510</td>
<td>SELECTED TOPICS/ECE</td>
<td>1-6</td>
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<tr>
<td>EE 514</td>
<td>ANALOG &amp; DIGITAL FILTER DESIGN</td>
<td>3</td>
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<td>Analog filter design via Butterworth, Chebyshev, and elliptical approximation. Active filter design using operational amplifiers. Digital filter design methods.</td>
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<td>EE 516</td>
<td>DIGITAL ELECTRONICS</td>
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<td>EE 518</td>
<td>NONLINEAR DYNAMICS &amp; CHAOS</td>
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<td>Topics: system stability, linearization, equilibrium/steady-state solutions, bifurcations, periodic solutions, limit cycles, oscillators, chaos, iterated maps and chaos control/synchronization. Various tools and methods used for analysis and design of nonlinear circuits and systems will be covered. Students should have prerequisite knowledge of electronics and signals and systems such as covered in EE 315 and EE 382.</td>
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<td>EE 521</td>
<td>ANTENNA DESIGN &amp; ANALYSIS</td>
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<td>Covers analytical methods and mathematical foundations for solving antenna radiation problems, based on Maxwell's equations. Different types of antennas will be studied, including wire, phased array, aperture, microstrip, and reflector antennas. Students should have prerequisite knowledge of electromagnetics, such as that covered in EE 308.</td>
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<td>EE 525</td>
<td>FUNDAMENTALS OF RADAR SYSTEMS</td>
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<td>An introduction to radar systems and basic radar analysis. Topics include common radar topologies and construction methods, transmission, reception and processing of radar signals that are embedded in noise. Particular focus on analysis of the radar range equation and its various terms. Students are expected to have prerequisite knowledge of signals and systems and random signals such as covered in EE 382 and EE 385.</td>
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<tr>
<td>EE 532</td>
<td>OPTICAL SYSTEMS DESIGN</td>
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<td>Introduction to the geometrical design and analysis of optical systems, and to the design principles of lens systems.</td>
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<tr>
<td>EE 534</td>
<td>OPTICAL FIBER COMMUNICATIONS</td>
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<td>Introduction to optical fibers and their transmission characteristics, optical fiber measurements, sources and detectors, noise considerations for digital and analog communications, optical fiber systems.</td>
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EE 541 - OPTICS I
Semester Hours: 3
Foundations and physics of geometrical optics, Fermat's principles and Huygen wavelets, refraction and reflection. The many forms of Snell's Law. Optical path lengths, geometrical wavefronts and rays. Ray tracing, ynu-chart and matrix methods. Gaussian imagery and paraxial optics, conjugate elements, cardinal points, and image-object relations. Stops and pupils, chief and marginal rays, vignetting, and the optical or Lagrange invariant. The y-ybar diagram, design of common systems: objectives, magnifiers, microscopes, collimators and detectors. Optical glasses and chromatic aberrations, wavefront and transverse aberrations, spot diagrams and ray fan plots.

EE 542 - PHYSICAL OPTICS
Semester Hours: 3
Scalar and electromagnetic waves, polarization, coherence, reflection and refraction; two beam and multiple beam interference, interferometers, Fabry-Perots, thin films, diffraction, and absorption and dispersion.

EE 543 - OPTICAL COMM SYS & NETWORKS
Semester Hours: 3
Spontaneous and stimulated emission, population inversion, optical resonators, three- and four-level systems, Q-switching and modelocking, semiconductor lasers, integrated optic waveguides and couplers, scanning systems, high power industrial applications. Includes a research project and oral presentation.

EE 570 - OPT & PHOTONIC SYSTEMS DESIGN
Semester Hours: 3
EE 586 - INTRO MODERN CONTROL SYSTEMS
Semester Hours: 3
EE 503 - RANDOM SIGNALS IN COMMUNICATION
Semester Hours: 3
EE 604 - DIGITAL IMAGE PROCESSING
Semester Hours: 3
EE 605 - CLASSICAL CONTROL DESIGN
Semester Hours: 3
Design of feedback, feedforward, and minor-loop controllers/compensators using classical control engineering techniques and classical performance criteria. Frequency domain synthesis of lead, lag, lead-lag, etc. compensators; tuning of PD and PID controllers; error budgets; use of commercial CAD software for classical control design and performance evaluation; digital simulation techniques. CAD laboratory sessions.

EE 607 - ROBOTIC SYSTEMS CONTROL
Semester Hours: 3
In-depth study of information, decision and control problems associated with robotic system design. Sensor systems, recognition and decision algorithms, kinematics and dynamics, trajectory planning, analog and digital controllers, adaptive and optimal control.

EE 609 - ELECTROMAGNETIC FIELD THEORY
Semester Hours: 3

EE 610 - SELECTED TOPICS/ECE
Semester Hours: 1-6
EE 612 - GRADUATE DESIGN PROJECT
Semester Hours: 3
Graduate design project in support of an M.S.E. program.

EE 613 - LASER ELECTRONICS
Semester Hours: 3

EE 614 - DATA COMPRESSION
Semester Hours: 3
Introduction to the fundamental theories and techniques of lossless and lossy data compression. Topics include Huffman codes, arithmetic codes, Golomb-Rice code, dictionary techniques, context-based compression, scalar quantization, vector quantization, transform coding, subband coding, wavelets, compression standards, and selected advanced topics of data compression.

EE 615 - ANALOG CIRCUIT DESIGN
Semester Hours: 3
Use of operational amplifiers to synthesize special-purpose filters and circuits for analog signal processing and conditioning; linear and switching power supplies; high-frequency effects; circuits for transmitters and receivers; digital circuits from an analog viewpoint; A/D and D/A converters; selected topics.

EE 616 - MICROELECT DEV/INTE CIRC
Semester Hours: 3

EE 617 - VLSI INTEGRATION DEVICES
Semester Hours: 3
Operation and modeling of the MOS transistor. Second-order considerations for a MOSFET, VLSI device fundamentals and scaling laws. Micron-length and submicron-length semiconductor devices. Basic technology and applications of VLSI. Impact of VLSI on computer architecture. VLSI computer aided design.

EE 618 - VLSI CIRCUITS
Semester Hours: 3

EE 619 - RADAR SYSTEMS
Semester Hours: 3
Radar range equation, noise & noise figure, radar losses, false alarm and detection probability, detection probability improvement techniques, matched filter theory, ambiguity function. Prereq: EE 525.

EE 620 - CMOS ANALOG CIRCUIT DESIGN
Semester Hours: 3

EE 622 - HARDWARE RELIABILITY
Semester Hours: 3
The objective for this course is to provide students with an understanding of the essential reliability physics of electronic devices as well as some of the practical technological considerations.

EE 629 - ANAL & COMP METH IN ELEC ENG I
Semester Hours: 3
Analytic and numerical solution techniques applicable to problems arising in engineering, utilizing complex variable theory, linear algebra, matrix theory, and transform methods.
EE 630 - ANAL & COMP METHODS ELEC EG II  
Semester Hours: 3  
Analytical and numerical solution techniques applicable to problems arising in electrical engineering. Partial differential equations, vector differential and integral calculus, special functions, Fourier analysis with applications and integral equations.

EE 632 - FOURIER OPTICS  
Semester Hours: 3  
Introducing the optical system as an invariant linear system, convolution, Sommerfeld's diffraction integral, Fourier Transform, angular spectrum, coherent and incoherent imaging, optical transfer function.

EE 633 - ELECTRO-OPTICAL ENGINEER  
Semester Hours: 3  
Propagation of optical beams in homogeneous and guiding media, optical resonators, and spectrum analyzers, theory of laser oscillation, some specific laser systems, parametric oscillators, electro-optical and acousto-optical modulators.

EE 634 - OPTICAL COMMUNICATIONS  
Semester Hours: 3  
Optical communication systems; counting statistics; the optical detector response process; direct detection; heterodyne detection parameter estimation in optical communications; pointing, spatial acquisition and tracking.

EE 642 - DATA & DIGITAL COMMUNICATION  
Semester Hours: 3  
Introduction to digital and data communications; transmission channels; modulation and coding; telephone networks; data communication standards; noise and distortion; computer interfacing; protocols. Prerequisite: EE 603.

EE 648 - DIGITAL SIGNAL PROCESSING  
Semester Hours: 3  
Theory and applications of signal processing by digital techniques. Difference equations, Z-transform theory, digital-filter design, fast Fourier transform, quantization effects, and discrete estimation. Applications in digital filtering, signal processing, data analysis and smoothing, and image processing. Students should have prerequisite knowledge of signals and systems such as covered in EE 383.

EE 654 - OPTICAL TESTING  
Semester Hours: 3  

EE 672 - DIGITAL PROC RANDOM SIGNALS I  
Semester Hours: 3  
Discrete signals, linear systems, spectral analysis and probability; and random discrete-time signals. Introduction to statistical interference, time-series analysis and spectral estimation of random discrete-time signals. Cross correlation and cross spectra, multitaper spectrum estimation and multivariable spectral analysis.

EE 673 - DIGITAL PROC RANDOM SIGNALS II  
Semester Hours: 3  
Parametric models for random signal processing; AR (autoregressive), MA (moving average), ARMA (autoregressive moving average), and Prony method. Two-dimensional spectral estimation; higher-order spectral analysis and multiresolution signal analysis.

EE 690 - UNIFORM GEOM THY DIFFRAC  
Semester Hours: 3  
Geometrical optics fields, geometrical optics reflected fields, two-dimensional wedge diffraction (GTD and UTD), three-dimensional wedge diffraction and corner diffraction, equivalent currents, diffraction at a smooth convex conducting surface, radar cross section.

EE 696 - GRAD INTERN EE ENGR  
Semester Hours: 1-9  
Active involvement in an engineering project in an engineering enterprise, professional organization or government agency that has particular interest and relevance to the graduate student. Permission of EE faculty member is required.
EE 699 - MASTER'S THESIS  
Semester Hours: 9  
Required each semester student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of nine hours of credit is awarded upon successful completion of master's thesis. The 0 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 0 hour option once in their career.

EE 700 - SAMPLED DATA CONT SYS  
Semester Hours: 3  
Classical and modern methods for analysis and design of sampled data-control systems; Ztransforms, transport lags, z and w plane analysis, state variables, and the transition matrix.

EE 701 - ADV LINEAR CONTROL THRY  
Semester Hours: 3  
Modern techniques for analysis and design of linear control systems. Matrix formulation, multivariable control systems, state variable concepts. Linear transformation, controllability, observability, discrete-time systems. Prerequisite: EE 586.

EE 703 - MODERN CONTROL DESIGN  
Semester Hours: 3  
Use of modern (state-variable) control concepts and theories to design high-performance controllers for multi-input/multi-output set-point regulation and servo-tracking/pointing problems. Modeling of uncertain disturbances; design of disturbance-accommodating controllers: introduction to adaptive and stochastic control. Use of commercial CAD software for modern control design and performance evaluation. CAD laboratory sessions. Prerequisite: EE 701.

EE 704 - NONLINEAR CONTROL SYSTEM  
Semester Hours: 3  
Classical and modern methods for analysis and design of nonlinear automatic control systems. State variables, phase plane, limit cycles, stability, describing functions, relay control, stabilization theory. Prerequisite: EE 701.

EE 705 - THEORY OPTIMAL CONTROL  
Semester Hours: 3  

EE 706 - KALMAN FILTERS  
Semester Hours: 3  
Review of continuous and discrete time systems, random variables and processes; matrix random processes; derivation of the first order, linear Kalman filter; derivation of the linear vector Kalman filter; derivation of the extended Kalman filter; design and implementation of specific Kalman filters. Prerequisite: EE 525 or EE 586.

EE 707 - INFORMATION THEORY  
Semester Hours: 3  
Self-information, entropy, mutual information, and channel capacity, encoding, error detecting and correcting codes. Sampling theorem. Discrete and continuous channels.

EE 710 - SELECTED TOPICS/ECE  
Semester Hours: 1-6

EE 711 - ANTENNA THEORY  
Semester Hours: 3  
Antennas and antenna arrays. Radiation patterns and impedance characteristics. Spheres, cylinders, horns, slots, microwave lenses, traveling-wave, and frequency independent antennas.

EE 716 - DEVICE MOD INTEG CIR DSG  
Semester Hours: 3  
EE 717 - SPACE APPL/ELECTROMAGNE
Semester Hours: 3
Plasma as a dielectric; dielectric functions for cold, warm, isotropic and anisotropic plasmas, body-plasma interaction; space craft electrodynamics, antennas in plasmas; mode of radiation, input impedance and radiation pattern, scattering problems involving plasmas.

EE 718 - MICROWAVE TECHNIQUES
Semester Hours: 3
EE 721 - ROBUST AND ADAPTIVE CONTROL
Semester Hours: 3
Introduction to fundamental ideas of robust and adaptive control. Effects of parameter and disturbance uncertainties, H-infinity and mu-synthesis ideas; parameter estimation techniques; adaptive control algorithms; stability considerations; model-reference and linear adaptive control techniques.
EE 722 - SLIDING MODE CONTROL
Semester Hours: 3
The basic and advanced theories and analytical techniques for modeling and analysis of systems dynamics in sliding manifolds. Traditional and High Order Sliding mode controller design. Discontinuous and equivalent control, robustness. Applications to control of electro-mechanical systems, reusable launch vehicle, air craft, spacecraft, and DC-to-DC power converters. Prerequisite: EE 701.
EE 723 - RADAR TRACKING
Semester Hours: 3
Alpha-Beta and Alpha-Beta-Gamma track filters, range, angle, Doppler frequency measurement and discriminators; implementation of range, angle, Doppler, and combined range/angle/Doppler trackers; tracking the presence of multipath, multiple target effects. Prerequisite: EE 619.
EE 724 - RADAR WAVEFORMS & SIGNAL PROCEDURE
Semester Hours: 3
Stretch Processing. Synthetic Aperture Radar and SAR signal processing, Space-time adaptive processing (STAP). Phase coded waveforms and processing. Frequency hop waveforms Prerequisite: EE 619.
EE 725 - ADVANCED RADAR TECHNIQUE
Semester Hours: 3
Modern radar systems for search and tracking are analyzed with emphasis on signal processing. Modeling and simulation of system and environment. Advanced techniques include CFAR, binary modulation, frequency agility, polarization agility, and synthetic aperture. Prerequisite: EE 619.
EE 726 - DECISION/ESTIMATION THEORY
Semester Hours: 3
Classical detection theory, including maximum likelihood, Neyman-Pearson, Bayes and minimax criteria. Estimation theory concepts and criteria, linear estimators, Kalman filters, maximum likelihood and least-squares estimator, matched filters, Cramer-Rao lower bound. Introduction to pattern recognition.
EE 727 - NUMERICAL METHODS ELECTROMAGNETISM
Semester Hours: 3
EE 733 - NONLINEAR OPTICS APPLICATIONS
Semester Hours: 3
Modeling of optical nonlinearities; Kerr, thermal and photoreflective effects; nonlinearity-induced beam distortion; applications of nonlinearities in crystals and fibers; quantum well and SEED devices; soliton-based communication system; nonlinear optical switches, deflectors and limiters; measurements of nonlinearities.
EE 734 - FIBER OPTICS
Semester Hours: 3
Propagation in dielectric slab and fibers with step and graded index of refraction; electromagnetic and ray optical methods; eikonal equations; ray trajectory; WKB method; paraxial approximation; weakly guiding structures.
EE 735 - STATISTICAL OPTICS
Semester Hours: 3

Introduction to random variables and random processes; first-order properties of light waves; coherence of optical waves, partial coherence and imaging systems, imaging in randomly inhomogeneous media, fundamental limits in photoelectric detection of light.

EE 738 - OPT TRANSF/PATTN RECOGN
Semester Hours: 3

Systems and transforms in diffraction theory; two-dimensional Fourier transform; Hankel transforms; generalized Hankel transforms; optical signals, correlation coherence; filtering; apodization; applications to optical pattern recognition.

EE 742 - WIRELESS COMMUNICATIONS
Semester Hours: 3

Design and analysis of wireless transmission systems. Prerequisite: EE 642.

EE 744 - ERROR CONTROL CODING
Semester Hours: 3

Linear block coding techniques, convolutional codes and the Viterbi decoding algorithm, iterative decoding algorithms and the codes to which they are applied, including Turbo Codes, Low-Density Parity-Check Codes, and Serially-Concatenated Codes. Prerequisite: EE 504.

EE 745 - MOD/PHASE LOCK TECH COMM
Semester Hours: 3


EE 747 - PATTERN RECOGNITION ALGORITHMS
Semester Hours: 3

EE 799 - DOCTORAL DISSERTATION
Semester Hours: 9

Required each semester student is enrolled and receiving direction on doctoral dissertation. The 0 hour option is only available to students who have successfully defended their dissertation and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 0 hour option once in their career.