<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>EE 500</td>
<td>RANDOM SIGNALS &amp; NOISE</td>
<td>3</td>
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<tr>
<td>EE 501</td>
<td>DIGITAL SIGNAL PROC ARCHITECTU</td>
<td>3</td>
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<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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<tr>
<td>EE 503</td>
<td>COMMUNICA SYS &amp; SIMULAT W/LAB</td>
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<td>Modern test equipment and computer-based simulation methods are used to conduct experiments in the area of communication systems. Hands-on experiments are conducted using digital oscilloscopes, arbitrary waveform generators, vector impedance meters and other relevant test and measurement equipment. Methods are investigated for signal modulation and demodulation; studies are conducted on AM, FM, PSK, PCM and delta modulation circuits and systems. Several types of filters are investigated, both analytically and experimentally. Properties and behavior of phase-locked loop are studied by using both hardware and numerical simulations.</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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<td>EE 505</td>
<td>INTRO CONTROL/ROBOTIC SY</td>
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<td>The basic theories and analytical techniques for modeling, analysis and control of dynamical systems. Transfer functions, block-diagrams, frequency response, stability criteria, series and feedback controller design, digital control. Introduction to the dynamic analysis and control of robotic systems.</td>
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<tr>
<td>EE 506</td>
<td>COMMUNICATION THEORY</td>
<td>3</td>
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<tr>
<td>EE 510</td>
<td>SELECTED TOPICS/ECE</td>
<td>1-6</td>
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<td>EE 510L</td>
<td>SELECTED TOPICS LABORATORY</td>
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<td>EE 514</td>
<td>ANALOG AND DIGITAL</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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<tr>
<td>EE 516</td>
<td>DIGITAL ELECTRONICS</td>
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<td>EE 519</td>
<td>DIGITAL ELECTRONICS LAB</td>
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<tr>
<td>EE 527</td>
<td>ELECTROMAGNETIC ENGINEERING</td>
<td>3</td>
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<tr>
<td></td>
<td>Review of Maxwell's equations, uniform plane waves in different types of media, reflection and transmission of uniform plane waves, transmission lines, microwave and fiber optic waveguides, antennas, wireless applications.</td>
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</table>
EE 532 - OPTICAL SYSTEMS DESIGN  
Semester Hours: 3  
Introduction to the geometrical design and analysis of optical systems, and to the design principles of lens systems.

EE 534 - OPTICAL FIBER COMMUNICATIONS  
Semester Hours: 3  
Introduction to optical fibers and their transmission characteristics, optical fiber measurements, sources and detectors, noise considerations for digital and analog communications, optical fiber systems.

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  

EE 553 - LASER SYSTEMS  
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 601 - LINEAR SYSTEMS  
Semester Hours: 3  
Formulation and solution by transform methods of differential equations of linear electrical and electromechanical systems, state equations, signal-flow graphs, and discrete-time systems.

EE 603 - RANDOM SIGNALS IN COMMUNICATION  
Semester Hours: 3  
Random processes applied to communication and control. Concepts covered include stationarity, correlation, power spectrum, Brownian motion, thermal noise, Markov processes, and queueing theory. Emphasis on systems with noisy excitation.

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 606 - STATISTICAL COMM THEORY
Semester Hours: 3
and prediction.

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
Mathematical approach to electromagnetic phenomena. Basic field concepts. Radiation and propagation. Waveguides and simple radiating and
scattering systems. Perturbational and variational techniques.

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 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
Analysis and design of microelectronic devices for integrated circuits. Properties of semiconductors important to microelectronic device operation.
Analysis and modeling of MOS devices and circuits. Analysis and modeling of metal semiconductor devices, junction diodes, bipolar transistors. Device
fabrication technology.

EE 617 - VLS 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
MOS device electronics. MOS processing and design rules. Circuit design with MOSFETS. MOS circuit technique. Combinational logic gate in CMOS.
Pseudo-NMOS logic gates. Very high performance digital circuits. Sequential logic circuits. Designing semiconductor memories. Low power CMOS VLSI
circuit design.

EE 619 - INTRO RADAR SYSTEMS
Semester Hours: 3
Topics include radar equation, CW radar, MTI and pulse Doppler radar, tracking radar, major systems components, detection in the presence of noise
and clutter, ambiguity, and resolution.
EE 620 - CMOS ANALOG CIRCUIT DESIGN  
Semester Hours: 3

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 ENG 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.

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.

EE 654 - OPTICAL TESTING  
Semester Hours: 3

EE 670 - OPTOMECHANICAL DESIGN & MANUF  
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, multilayer 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 693 - ECE CAPSTONE  
Semester Hours: 1-3

The purpose of this course is for students to perform research in a subject gained from courses taken at the graduate level. Students will be introduced to rhetorical theory, training in oral and written communication skills. They are required to organize and deliver oral and written technical presentations on individual research, journal articles, or design projects.

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: 1-9

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 1 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 1 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.

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.

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.

EE 705 - THEORY OPTIMAL CONTROL  
Semester Hours: 3


EE 706 - KALMAN FILT TECH CON & SIG PRO  
Semester Hours: 3

Basic concepts of Kalman Filtering Theory with applications to: 1) analysis and design of control systems for dynamic processes with noisy sensors and random-type disturbance inputs, and 2) estimation, smoothing and prediction of information in noisy signals; Optimum Stochastic Control and the Separation Principle. Matrix Riccati Equation, Covariance Matrix, Orthogonal Projection Theorem.

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 709 - DISCR RANDOM SIG/SPEC ES  
Semester Hours: 3

Review of linear systems theory, random discrete processes, classical spectral estimation, parametric models of discrete random processes, autoregressive (AR), moving average (MA), autoregressive moving average (ARMA) models.
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 APPLI/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.

EE 724 - RADAR WAVEFORMS & SIGNAL PROCE
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.

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.

EE 726 - DECIS/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 - NUMER METH ELECTROMAGNET
Semester Hours: 3

EE 733 - NONLINEAR OPTICS APPLICATIONS  
Semester Hours: 3

Modeling of optical nonlinearities: Kerr, thermal and photorefractive 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 737 - CHAN CHAR COMM RAND MEDI  
Semester Hours: 3

Modeling stationary and not strictly stationary random media; scatter communications channels; line of sight communication channels; weak scattering and strong scattering.

EE 738 - OPT TRANSF/PATTN RECOGNI  
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.

EE 744 - CODING THRY & SPREAD SPECTRUM  
Semester Hours: 3

Linear block coding techniques, convolutional codes and the Viterbi decoding algorithm, probability of error bounds, channels with intersymbol interference and additive Gaussian noise. Introduction to spread spectrum direct sequence and frequency hopping methods.

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


EE 747 - PATTERN RECOGNITION ALGORITHMS  
Semester Hours: 3

EE 748 - DIGITAL SIG PROC ALG/APP  
Semester Hours: 3

Introduction to digital signal processors hardware architecture. Applications of digital signal processing in telecommunications, speech and image processing, radar and sonar. Development and implementation of DSP algorithms; DSP laboratory session.

EE 799 - DOCTORAL DISSERTATION  
Semester Hours: 3-9

Required each semester student is enrolled and receiving direction on doctoral dissertation.