Electrical and Computer Engineering

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Mission

The mission of the Electrical and Computer Engineering Department is to develop and maintain high quality undergraduate and graduate programs in electrical, computer, and optical engineering to meet the needs of its constituents, and to participate in scholarly and productive research that contributes to the economic well-being and quality of life for the residents of Huntsville, the State of Alabama, and the citizens of the United States of America.

Degree Programs

The ECE Department supports several degree programs that provide a unique academic and research experience for students including:

- Master of Science in Engineering (Computer Engineering)
- Master of Science in Engineering (Electrical Engineering)
- Master of Science in Software Engineering
- Master of Science in Cybersecurity
- Doctor of Philosophy in Computer Engineering
- Doctor of Philosophy in Electrical Engineering

The Department of Electrical and Computer Engineering (ECE) offers opportunities for advanced work in a variety of fields including radar and radar systems, digital signal processing, digital communications, digital and analog electronics, computer architecture, parallel processing, software engineering, software safety, optics, and photonics.

Co-located in one of the nation's largest research parks, UAH has the intellectual and social environment to provide a well-rounded, technologically-oriented degree. ECE graduate students have outstanding opportunities for research, collaboration, cooperative employment, and future employment with government research centers and high-tech businesses. In addition, a number of UAH research centers collaborate with the ECE Department, including the Center for Rotorcraft Systems Engineering and Simulation, the Center for Modeling, Simulation & Analysis, the Center for Applied Optics, and the Nano and Micro Devices Center.

Prospective and current students are encouraged to visit the ECE Department web site at www.uah.edu/eng/departments/ece for information about faculty research interests, ongoing research projects, funding opportunities and course availability. Other information about the ECE graduate programs are available in the department office.

MSE in Computer or Electrical Engineering

The MSE in Computer or Electrical Engineering each require 31 semester hours and consist of two options. The thesis option requires 24 semester hours of graduate coursework and a minimum of 6 semester hours of thesis. Students under this option, must complete a written thesis and an oral defense. The non-thesis option requires 30 hours of graduate coursework and 1 hour of Practicum.

Students wishing to pursue a MSE degree in Computer or Electrical Engineering must meet the admission requirements of UAH Graduate Studies as well as the College of Engineering. Students who are admitted to these programs must file a program of study made in consultation with their faculty advisor.

MS in Software Engineering (MSSE)

The MSSE degree program has two options: Plan I and Plan II. Plan I requires 24 semester hours of graduate coursework and a minimum of 6 semester hours of thesis. Plan I students must also write and defend a thesis as a final examination. Plan II requires 36 semester hours of coursework including 6 semester hours of Software Studio. Students who are admitted to these programs must file a program of study made in consultation with their faculty advisor. Students wishing to pursue a MSSE degree must meet the admission requirements of UAH Graduate Studies, as well as the College of Engineering.

MS in Cybersecurity (MSCBS)

The MSCBS degree program is an interdisciplinary program with the Colleges of Science and Business with a distinct computer engineering track. The MSCBS has one option: 30 semester hours of graduate coursework with no thesis. Students who are admitted to these programs must file a program of study made in consultation with their faculty advisor. Students wishing to pursue a MSCBS degree must meet the admission requirements of UAH Graduate Studies, as well as the College of Engineering.

PhD in Computer or Electrical Engineering

The ECE Department offers a program leading to the degree of Doctor of Philosophy (PhD) in Computer or Electrical Engineering. The PhD is a research-oriented degree awarded upon completion of a defined program of study, demonstration of scholarly competence, distinctive achievement in a special field, and demonstrated ability to do an independent, original investigation. Demonstration of substantial scholarly research accomplishments, rather than mere accumulation of residence and course credits, is an essential consideration in awarding the PhD degree.

The ECE Department doctoral programs require 48 semester hours of approved coursework. Students must register for a minimum of 18 semester hours of dissertation research. Students must meet with their doctoral advisors to develop a program of study, which lists the approved coursework required for the PhD. In addition, students must register for dissertation research every semester after the completion of the program of study until the dissertation defense. At the end of the coursework, a student must pass a Qualifying Examination. Finally, a student must write an acceptable dissertation which must be defended in front of the supervisory committee. More details about these examinations are available in the department office. In order for a student's doctoral dissertation to be approved, at least one refereed journal or refereed national conference article must be published or accepted for publication.

Students wishing to pursue a PhD must meet the admission requirements of UAH Graduate Studies as well as the College of Engineering. Students who do not have the appropriate bachelor's or master's degree from an ABET-accredited Computer or Electrical Engineering program must complete the foundation courses described below or demonstrate proficiency by completing similar courses or providing evidence based on employment experience.

Foundation Courses

The Computer and Electrical Engineering degree programs described above assume that students have a bachelor's degree and/or master's degree in Computer or Electrical Engineering, respectively.

To pursue the MSE or PhD in Computer Engineering, students who do not have a bachelor's degree in Computer Engineering should complete coursework or demonstrate knowledge in the following CPE foundation areas[1]:

Programming Languages/Software Engineering		
CPE 211	INTRO COMPUTER PROG FOR ENGR	3
CPE 212	FUNDAMENTALS SOFTWARE ENGRG	3
CS 317	INTRO DESIGN/ANALYSIS OF ALG	3
Digital Logic Design/Electronics		
EE 202	INTRO DIGITAL LOGIC DSGN	3
EE 315	INTRO ELECTRONIC ANAL & DESIGN	3
Computer Organization/Microprocessors		
CPE 221	COMPUTER ORGANIZATION	3
CPE 323	INTRO TO EMBEDDED COMPUTER SYS	3
CPE 531	INTRO COMPUTER ARCHITECTURE	3
Total Semester Hours		**24**

1 An entering student can demonstrate knowledge of the material in one of the following ways: completing the courses at UAH, completing similar courses at another institution, or by providing evidence based on employment experience. A student may be required to successfully pass a placement exam to demonstrate their knowledge of the material. Up to 3 credit hours from CPE 531 may be applied towards a student's graduate program if: (1) The student has completed the foundation courses at UAH as a part of their graduate program, and (2) the student is enrolled in Plan II (non-thesis) MSE in the CPE program.

To pursue the MSE or PhD in Electrical Engineering, students who do not have a bachelor's degree in Electrical Engineering should complete coursework or demonstrate knowledge in the following subjects[1]:

EE 202	INTRO DIGITAL LOGIC DSGN	3
EE 213	ELECTRICAL CIRCUIT ANALYSIS I	3
EE 307	ELECTRICITY & MAGNETISM	3
EE 315	INTRO ELECTRONIC ANAL & DESIGN	3
EE 382	ANALY METH CONTINUOUS TIME SYS	3
EE 383	ANALY METH MULTIVARIABLE	3
EE 385	RANDOM SIGNALS & NOISE	3
Total Semester Hours		**21**

[1] An entering student can demonstrate knowledge of the material in one of the following ways: completing the courses at UAH, completing similar courses at another institution, or by providing evidence based on employment experience. A student may be required to successfully pass a placement exam to demonstrate their knowledge of the material.

To pursue either the MSSE or the MSCBS degrees, students who do not have a Computer Science or Computer Engineering bachelor's degree from an ABET-accredited program must complete the following courses or demonstrate knowledge in those subject areas[1]. Experience in the development of a large scale, industrial strength software system is highly desirable.

CPE 211	INTRO COMPUTER PROG FOR ENGR (or programming in C, C++ or Java)	3
CPE 212	FUNDAMENTALS SOFTWARE ENGRG (Data Structures)	3
CS 214	INTRO DISCRETE STRUCTURE	3
CS 317	INTRO DESIGN/ANALYSIS OF ALG	3
CPE 431	INTRO COMPUTER ARCHITECTURE	3
CPE 434	OPERATING SYSTEMS	3
Total Semester Hours		**18**

[1] An entering student can demonstrate knowledge of the material in one of the following ways: completing the courses at UAH, completing similar courses at another institution, or by providing evidence based on employment experience. A student may be required to successfully pass a placement exam to demonstrate their knowledge of the material.

Master's Programs in Electrical & Computer Engineering

- Computer Engineering, MSE (http://catalog.uah.edu/grad/colleges-departments/engineering/electrical-computer-engineering/computer-engineering-mse)
- Electrical Engineering, MSE (http://catalog.uah.edu/grad/colleges-departments/engineering/electrical-computer-engineering/electrical-engineering-mse)
- Master of Science in Cyber Security (http://catalog.uah.edu/grad/colleges-departments/engineering/electrical-computer-engineering/computer-engineering-mse-information-assurance-concentration)
- Master of Science in Software Engineering, MSSE (http://catalog.uah.edu/grad/colleges-departments/engineering/electrical-computer-engineering/software-engineering-msse-master-of-science)

Doctoral Programs in Electrical & Computer Engineering

- Computer Engineering, PhD (http://catalog.uah.edu/grad/colleges-departments/engineering/electrical-computer-engineering/computer-engineering-phd-shared-with-uab)
- Electrical Engineering, PhD (http://catalog.uah.edu/grad/colleges-departments/engineering/electrical-computer-engineering/electrical-engineering-phd)

CPE 512 - INTRO PARALLEL PROGRAMMING
Semester Hours: 3

Introduction to processing in parallel and distributed computing environments. General conceptsof parallel machine models, processes, mutual exclusion, process synchronization, message passing, and programming languages for parallel computing and scheduling. Design and analysis of parallel algorithms. Parallel programming environments: Pthreads for shared memory multiprocessor systems and PVM/MPI for distributed networked computers.

CPE 523 - HARDWARE/SOFTWARE CO-DESIGN
Semester Hours: 3

Study and design of Systems On a Chip (SOC). Emphasis on Field Programmable realizations of SOC systems.

CPE 526 - VLSI HARDWARE DESC LANG/MODL/S
Semester Hours: 3

Modern VLSI design techniques and tools, such as silicon compilers, (V)HDL modeling languages, placement and routing tools, synthesis tools, and simulators. Students will design, simulate, and layout using both programmable logic families and ASIC libraries.

CPE 527 - VLSI DESIGN I
Semester Hours: 3

Introduction to VLSI design using CAD tools, CMOS logic, switch level modeling, circuit characterization, logic design in CMOS, systems design methods, test subsystem design, design examples, student design project. Design project to be fabricated and tested in CPE 528. Students enrolling in CPE 527 must enroll concurrently in CPE 527L.

CPE 527L - LABORATORY
Semester Hours: 0

Students enrolling in CPE 527L must enroll concurrently in CPE 527.

CPE 528 - VLSI DESIGN II
Semester Hours: 3

Advanced experience with CAD tools for VLSI design, IC testing. Design project from CPE 527 will be fabricated and tested. Implementation and verification of test programs, IC testing and troubleshooting, legal, economic, and ethical design issues. Oral presentations and written reports are required. Students enrolling in CPE 528 must enroll concurrently in CPE 528L.

CPE 528L - LABORATORY
Semester Hours: 0

Students enrolling in CPE 528L must enroll concurrently in CPE 528.

CPE 531 - INTRO COMPUTER ARCHITECTURE
Semester Hours: 3

Existing computer structures. Computer organization with emphasis on busing systems, storage systems, and instruction sets. Special purpose architecture, performance models and measures, VLSI influence on architecture.

CPE 534 - OPERATING SYSTEMS
Semester Hours: 3

Study of the fundamentals of operating systems. Emphasis on processes, file management, interprocess communication, input-output, virtual memory, networking and security.

CPE 536 - INTERNALS OF MODERN OPER SYS
Semester Hours: 3

In depth study of the design of modern operating systems such as Unix, NT, and Linux. Emphasis on the internals and implementation details of interrupt processing, real-time clocks, device independent I/O, process management, memory management, file management.

CPE 538 - REAL TIME & EMBEDED SYSTEMS
Semester Hours: 3

Study of design methodologies for reliable real time systems.

CPE 549 - INTRO TO CYBERSECURITY ENGINRG
Semester Hours: 3

Introduction to cryptography and computer security through hardware and physical security to a knowledge of audit methods, security management, and public law. The course will introduce security engineering skills such as business process analysis, software security, IAE evaluation, and IAE testing.

CPE 549L - INTRO CYBERSECURITY ENG LAB
Semester Hours: 0

Students enrolling in CPE 549 must enroll concurrently in CPE 549L.

CPE 561 - TRANSLATION SYSTEMS
Semester Hours: 3

Grammars, parsers, and lexical analyzers; implementation of translators via top-down and bottom up techniques; grammar analysis to identify ambiguities. Practical applications of translators including conversion of file formats and compilation of traditional computer languages.

CPE 590 - SPECIAL TOPICS IN COMP ENGR
Semester Hours: 1-3

CPE 590L - SELECTED TOPICS LABORATORY
Semester Hours: 0

CPE 601 - SURVEY INFORMATION ASSURANCE
Semester Hour: 1

CPE 610 - SELECTED TOPICS IN COMPUTER EN
Semester Hours: 1-6

CPE 612 - PARALLEL ALGORITHMS
Semester Hours: 3

Introduction to metrics describing the performance and scalability of parallel algorithms. Performance analysis of parallel algorithms for performing sorting, matrix multiplication, solving linear equations, and FFT.

CPE 613 - GEN PURPOSE GPU COMPUTING
Semester Hours: 3

The focus of this course is to introduce emerging techniques and programming paradigms that can be used to accelerate the processing speed of scientific and other high performance applications using Graphics Processing Units, GPUs. GPUs represent low-cost highly parallel video processing hardware that can be programmed for general purpose applications using UDA/OpenCL software architecture. The course will survey the current state of research and industrial activity and will give student's hands-on experience implementing designapplications on real-world GPU facilities for a wide range of scientific applications.

CPE 619 - MODELING & ANAL COMPU/COMMUN S
Semester Hours: 3

Modeling of single and multiprocessor systems, single and multi-stage interconnection networks, Computer Networks. Analysis using Stochastic processes, Markov and Queuing techniques. Modeling using Petri Nets and Finite State models.

CPE 621 - ADVANCED EMBEDDED SYSTEMS
Semester Hours: 3

Deeply embedded low-power wireless sensors. Low-power microcontroller architectures, sensor platform architecture, wireless intelligent sensors, low power wireless communication standards, battery powered systems, resource constrained operating systems, data aggregation/sensor synergy, and collaborative signal processing.

CPE 625 - CMOS ANALOG CIRCUIT DESIGN
Semester Hours: 3

Analog circuit design in CMOS technology. CMOS processing technology. MOS transistor modeling. Basic current mirrors and single-stage amplifiers. Noise analysis and modeling. Basic OPAMP design and compensation. Advanced current mirrors and OPAMPS. Bandgap references. Oscillators. CMOS technology characterization for radio-frequency (RF) design.

CPE 626 - ADVANCED VLSI DESIGN
Semester Hours: 3

Advanced VLSI Design. Case study of the VLSI design of a modern RISC processor using a Hardware Description Language.

CPE 628 - TESTING OF HARDWARE SYSTEMS
Semester Hours: 3

Introduction to testing of digital electronic circuits and systems. Topics include: fault modeling, testing problems, testing schemes, test generation for combinational and sequential circuits, the complexity of testing, design for testability, built-in self-testing and boundary scan.

CPE 631 - ADV COMP SYSTEMS ARCHITECTURE
Semester Hours: 3

Study of architectural features of modern processors, including cache memories and memory systems, pipeline designs, branch prediction techniques. Design of superscalar, multithreaded VLIW processors, code optimization for such systems will be studied. Quantitative evaluation of architectural features are emphasized throughout the course.

CPE 633 - FULT-TOLERANT COMPUTING SYSTEM
Semester Hours: 3

Analysis and design of very high reliability and availability systems. Fault types, reliability techniques, and maintenance techniques. Case studies of high-availability long-life, life-critical systems. Both hardware and software techniques for achieving fault-tolerance will be studied.

CPE 635 - SYSTOLIC ARRAY PROCESSING
Semester Hours: 3

Systolic structure of fast algorithms and switchable array realizations.

CPE 641 - DATA & DIGITAL COMMUNICATIONS
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.

CPE 643 - OPTICAL COMMUNICATIONS
Semester Hours: 3

CPE 645 - COMPUTER NETWORK SECURITY
Semester Hours: 3

Principles and concepts of computer network security. Introduction to cryptography, confidentiality, authentication, digital signatures, E-mail security, IP security, web security, intruders, malicious software, firewall, and other network security-related issues.

CPE 646 - MOBILE & WIRELESS NETWORKS
Semester Hours: 3

High-level issues in mobile and wireless networks. The main topics are mobiile IP, mobile Ad hoc NETworks (MANETS) wireless sensor networks, wireless LAN, Bluetooth, cellular networks, satellite systems and security issues in mobiles and wireless networks.

CPE 647 - UBIQUITOUS COMPUTING
Semester Hours: 3

The course is based on the new "anytime, anywhere" computing paradigm, also known as ubiquitous computing. This course is project oriented, and explores issues of mobile, wireless, and distributed computing in Internet environment, advanced human-computer interfaces, and power efficient computing.

CPE 648 - ADVANCED COMPUTER NETWORKS
Semester Hours: 3

Advanced principles and concepts of general-purpose computer networks, with a special emphasis to internetworking and Internet. Transport and higher level protocols emphasis. Programming issues. High-speed networking, congestion control, data compression, security and distributed processing will be covered.

CPE 649 - ADV CYBERSECURITY ENGINEERING
Semester Hours: 3

Introduction to topics ranging from how to attack computer systems and networks to how to protect and recover from attacks on computer systems and networks. Basic process utilized by computer attackers in order to develop a complete understanding and appreciation of the threat to information assurance. Process of detecting, preventing, and recovering from information assurance attacks. Intrusion Detection and Prevention Systems, Auditing, Security Vulnerability Assessments, and the Incident Response process.

CPE 649L - ADV CYBERSECURITY ENG LAB
Semester Hours: 0

Students enrolling CPE 649 must enroll concurrently in CPE 649L.

CPE 656 - SOFTWARE ENGRG STUDIO I
Semester Hours: 3

This is the first course in a two course studio series required for the MSSE degree in the College of Engineering. Students will work in small design teams on medium sized software projects. Activities include developing requirements, designing and constructing system prototypes, developing and implementing test and verification plans, and presenting the project for evaluation. The practice of software design and evaluation will be conducted in an iterative cycle using best software engineering pactices, so that design and execution can be refined over the lifecycle of the project.

CPE 658 - SOFTWARE ENGRG STUDIO II
Semester Hours: 3

This is the second course in a two course studio series required for the MSSE degree in the College of Engineering. Students will work in small design teams on medium sized software projects. Activities include developing requirements, designing and constructing system prototypes, developing and implementing test and verification plans, and presenting the project for evaluation. The practice of software design and evaluation will be conducted in an iterative cycle using best software engineering pactices, so that design and execution can be refined over the lifecycle of the project.

CPE 690 - SELECTED TOPICS COMPUTER ENGRG
Semester Hours: 1-6

CPE 692 - CYBERSECURITY CAPSTONE
Semester Hours: 3

A capstone course emphasizing the intergration of various principles, theories, and techniques for developing, implementing and using cybersecurity strategies and applications in organizations. Includes readings, lectures, tours, situation analysis, cases, and the completion of a major practical project. Normally taken in the last semester of a student's program. Minimum grade B required. Prerequisites: CS, 585, CPE 549, IS 660, IS 663.

CPE 695 - PROJECTS IN COMPUTER ENGRG
Semester Hours: 3

CPE 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 9 hours 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.

CPE 710 - SEL TOPICS IN PARALLEL PROC
Semester Hours: 3

CPE 715 - SELECTED TOPICS IN COMPUTAT TH
Semester Hours: 3

CPE 720 - SELECTED TOPICS IN VLSI DESIGN
Semester Hours: 3

CPE 726 - ALGORITHMS FOR VLSI DESIGN TOO
Semester Hours: 3

Tools for VLSI Design. This course is concerned with the algorithms found in VLSI design tools.

CPE 730 - SELECTED TOPICS IN COMPUTER SY
Semester Hours: 3

CPE 731 - DISTRIBUTED SHARED MEMORY SYS
Semester Hours: 3

Study issues related to performance, granularity of sharing, multithreading, cache coherence, memory consistency models, pull vs push cacheing, false sharing, thread migration. Case studies systems, including DASH, FLASH ThreadMarks, SHRIMP, Calypso, Alewife to understand these issues.

CPE 735 - SELECTED TOPICS IN OPERATING S
Semester Hours: 3

CPE 740 - SPEC TOPICS COMPUTER NETWORKS
Semester Hours: 3

CPE 742 - PARALLEL PROCESS DESIGN
Semester Hours: 3

CPE 748 - MOBILE & WIRELESS NETWORKS
Semester Hours: 3

High-level issues in mobile and wireless networks. The main topics are mobile IP, Mobile Ad hoc NETworks (MANETs), wireless sensor networks, wireless LAN, Bluetooth, cellular networks, satellite systems, and security issues in mobiles and wirless networks.

CPE 760 - SEL TOPICS COMPILER/TRANSLAT S
Semester Hours: 3

CPE 790 - SEL TOPICS COMPUTER ENGRG
Semester Hours: 1-6

CPE 795 - RESEARCH IN COMPUTER ENGRG
Semester Hours: 1-6

CPE 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9

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

EE 500 - RANDOM SIGNALS & NOISE
Semester Hours: 3

Random variables and probabilistic description of signals. Introduction to random processes: autocorrelations, cross correlations, power spectral density. Noise analysis: thermal, shot, white, colored. Response of electrical systems to random inputs.

EE 501 - DIGITAL SIGNAL PROC ARCHITECTU
Semester Hours: 3

Introduction to digital signal processor architecture, applications, assembly language programming, and development tools for designing and implementing DSP systems.

EE 503 - COMMUNICA SYS & SIMULAT W/LAB
Semester Hours: 3

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.

EE 504 - INTRO DATA COMMUNICA NETWORKS
Semester Hours: 3

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.

EE 505 - INTRO CONTROL/ROBOTIC SY
Semester Hours: 3

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.

EE 506 - COMMUNICATION THEORY
Semester Hours: 3

Review of elementary signals and systems including the Hilbert transform, cross and auto correlation, power density spectrum, and the Wiener-Khintchine theorem. Butterworth and Chebyshev lowpass filters. Bandpass signals and systems. The lowpass equivalent of a bandpass signal/system. Commonly used forms of linear and nonlinear modulation. Demodulation methods and circuits. Phase lock and frequency feedback techniques.

EE 510 - SELECTED TOPICS/ECE
Semester Hours: 1-6

EE 510L - SELECTED TOPICS LABORATORY
Semester Hours: 0

EE 514 - ANALOG AND DIGITAL
Semester Hours: 3

Analog filter design via Butterworth, Chebyshev, and elliptical approximation. Active filter design using operational amplifiers. Digital filter design methods.

EE 516 - DIGITAL ELECTRONICS
Semester Hours: 3

Introduction to digital electronics. The Metal-Oxide-Semiconductor (MOS) transistor. MOS inverters and gate circuits. Bipolar junction transistors, ECL inverters, and bipolar digital gates. Semiconductor memories. Circuit design for VLSI.

EE 519 - DIGITAL ELECTRONICS LAB
Semester Hour: 1

EE 527 - ELECTROMAGNETIC ENGINEERING
Semester Hours: 3

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.

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

The basic ideas and techniques of modern control theory. Analytical techniques for modeling, analysis and control of MIMO dynamic systems. State variable description of dynamic systems. State variable feedback control design and state observers. Kalman-filtering. Fundamentals of nonlinear systems analysis. Introduction to discrete time system modeling, analysis and control. Basics of adaptive and optimal control. Applications to aerospace and electric power systems.

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 COMMUNICATIO
Semester Hours: 3

Random processes applied to communication and control. Concepts covered include stationarity, correlation, power spectrum, Brownian motion, thermal noise, Markov processes, and queuing theory. Emphasis on systems with noisy excitation.

EE 604 - DIGITAL IMAGE PROCESSING
Semester Hours: 3

Review of digital filters. Spatial filters and realizations. Edge and wedge detectors. Derivative matrices and u-notch, r-notch filters. Periodic images, their transformation and scanning, their two-dimensional Fourier transforms. Rational vectors and image filtering.

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

Generalized harmonic analysis. Correlation, convolution, power density spectra. Probability and statistics. Correlation detection. Optimum linear filtering 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

Resonant optical cavities. Atomic radiation. Laser oscillation and amplification. General characteristics of lasers. Laser excitation. Semiconductor lasers. Gas discharge phenomenon. Transition rates. Spectroscopy of common lasers. Detection of optical radiation.

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 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 funtions, Fourier analysis with applications and integral equations.

EE 632 - FOURIER OPTICS
Semester Hours: 3

Introducing the optical system as an invariant linear system, convolution, Sommerfield'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, Ztransform 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, 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 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 rhetorial theory, training in oral and wirtten 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

General theory of optimal control of dynamic processes. Calculus of variations. Hamilton-Jacobi theory. Pontryagain?s maximum principle, dynamic programming.

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

Fundamental limits in integrated circuits. Advanced and detailed development of the theory of MOS and bipolar transistors. MOS and bipolar transistor models for IC design. Numerical algorithms for modeling microelectronic devices. Device modeling and simulation for radio frequency (RF) application. Computer-aided design and VLSI device development.

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

Network representations and analysis of microwave devices. Discontinuities from a circuit point of view. Symmetry consideration. Scattering matrices in circuit design. Cavity resonators.

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

Review of concepts in electromagnetics, antennas and scattering problems, method of moments and applications, finite difference and finite element methods, numerical solutions of transient problems associated with broadband systems, impulse response, direct solution of field equations in time domain.

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

Treatment of analog and digital phase locked loops. Applications in carrier regeneration, demodulation, and synthesis discussed. Linear and nonlinear PLL models and analysis. Noise analysis via Volterra Series and Fokker-Planck equation. False lock phenomenon.

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.