Electrical and Computer Engineering (ESE)

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Degrees awarded: M.S. in Electrical Engineering; M.S. in Computer Engineering; Ph.D. in Electrical Engineering; Ph.D. in Computer Engineering

The fields of electrical and computer engineering are in an extraordinary period of growth; new application areas and increased expectations are accelerating due to new technologies and decreased costs. The Department of Electrical and Computer Engineering, in the College of Engineering and Applied Sciences, is involved in graduate teaching and research in many of these areas, including circuits and VLSI, communications and signal processing, computer engineering, networking, and semiconductor devices and quantum electronics. The Department has laboratories devoted to research and advanced teaching in the following areas: communications, computing, digital signal processing, DNA sequencing, engineering design methodology, fiber optic sensors and computer graphics, high-performance computing and networking, machine vision, micro and optoelectronics/VLSI, parallel and neural processing, and telerobotics.

Since Long Island contains one of the highest concentrations of engineering-oriented companies in the country, the Department is particularly strongly committed to meeting the needs of local industry. As part of this commitment, most graduate courses are given in the late afternoon or evening, so as to be available to working engineers on Long Island.

The value of this commitment to industry is evidenced by the support received by the Department in return; in particular, from AT&T, Intel Corporation, Lucent Technologies, Motorola, Texas Instruments, and Westinghouse.

The Department of Electrical and Computer Engineering offers graduate programs leading to the M.S. and Ph.D. degrees. Graduate programs are tailored to the needs of each student to provide a strong analytical background helpful to the study of advanced engineering problems. Ample opportunities exist for students to initiate independent study and to become involved in active research programs, both experimental and theoretical.

Areas of Emphasis in Graduate Study

Areas of emphasis in current research and instruction are Communications and Signal Processing, Computer Engineering, Semiconductor Devices and Quantum Electronics, Circuits, and VLSI.

Specialties that fall under one or more of the above categories include: biomedical electronics, computer networks, computer vision, digital computer-aided design, communications, fiber optic sensors, image processing, integrated circuit fabrication, microprocessors, novel electronic devices, optical signal processing, parallel and distributed computing, signal processing, and VLSI. Theoretical and experimental programs reflecting these areas are currently underway and students are encouraged to actively participate in these efforts. Outlined below is an overview of the Department's research areas.

Communications and Signal Processing

Subject areas of current interest include coding and modulation techniques; communications traffic; computer vision; data compression; detection and estimation; digital communication; high-speed data and computer communication networks; image analysis and processing; mobile, wireless, and personal communications; spectrum estimation; and statistical signal processing.

Computer Engineering

The goal of computer engineering in the Department is to provide a balanced view of hardware and software issues. The areas of expertise in the program include artificial neural networks, communications and signal processing, computer networks, computer vision, embedded microprocessor system design, fault tolerant computing, high-performance computer architecture, interconnection networks and high-speed packet switching, parallel and distributed computing, and software engineering.

Semiconductor Devices and Quantum Electronics

The program of courses and research pertinent to electromagnetics, optics, and solid-state electronics ranges from a study of the fundamental electronic processes in solids and gases through a description of the mechanism that yields useful devices, to a study of the design simulation and fabrication of integrated circuits. The program's scientific interests center on physics, characterization, and development of optoelectronic devices and systems. Over the past several years, major efforts have focused on the studies of physics of semiconductor lasers and detectors. The Department is also heavily involved in developing coherent fiber optic sensors, integrated fiber optics, and optical processors.

Circuits and VLSI

The program in the Circuits and VLSI area addresses problems associated with modeling, simulation, design, and fabrication of analog, digital, and mixed-signal integrated circuits. Analog and mixed-mode integrated circuit (IC) devices have important applications in many fields including avionics, medical technology, and space technology. The Department offers basic and advanced courses covering the following subjects: analog circuit design; design automation for analog, digital, and mixed-mode circuits; device modeling; integrated circuit technology; software tools for circuit design and simulation; VLSI circuits; testing of analog and digital ICs; and VLSI systems for communications and signal processing.

Facilities

The Department operates laboratories for both teaching and research:

The Advanced IC Design and Simulation Laboratory contains equipment and computing facilities for the design, simulation, and characterization of analog, digital, and mixed-signal integrated circuits. The lab is equipped with several SUN workstations and

PCs, and assorted electronic measurement equipment.

The Communications, Signal Processing, and Networking (COSINE) Laboratory is equipped with modern computers with specialized software for research in networks, signal processing, and telecommunications. The computers are connected to Departmental computing facilities allowing access to shared campus resources and the Internet.

The Computer-Aided Design Laboratory provides a network of 386-based workstations. Advanced computer-aided design software for analog and digital systems design is available on these workstations.

The Computer Vision Laboratory has state-of-the-art equipment for experimental research in three-dimensional machine vision. The facilities include desktop computers, imaging hardware, and printers.

The Digital Signal Processing Research Laboratory is involved in digital signal processing architectures and hardware and software research. The laboratory is presently active in the development of algorithms to be implemented on a variety of signal processing chips.

The Fluorescence Detection Laboratory is involved in the design, development, implementation, and testing of various DNA sequencing instruments. Research areas include capillary electrophoresis phenomena, design and development of analog and digital integrated circuits, DNA sequencing, fast data acquisition and transfer, laser-induced fluorescence detection, signal processing, and single photon counting techniques.

The Graduate Computing Laboratory has 12 Windows 2000 Professional-based Windows PCs, equipped with Microsoft Office XP, Microsoft Visual Studio, X-Windows for UNIX connectivity, Adobe Acrobat reader, Ghost script and Ghost view. There is an HP LaserJet 5Si/MX printer. The lab is also equipped with eight Sun Blade 100 machines. These machines run Sun Solaris 8 operating systems and are connected to the Departmental UNIX servers. Industry standard packages such as Cadence tools, Hspice, Matlab, and Synopsys are available from the application servers.

The High Performance Computing and Networking Research Laboratory is equipped to conduct experimental research in the broad area of networking, including interconnection networks, multicast communication, optical networks, and wireless/mobile networks. The laboratory has one Dell PowerEdge 1800 server, nine Dell OPtiPlex Gx620MT PCs, one Sun Ultra workstation with dual processors, and four Sun Ultra 5 workstations. All machines are networked.

The Medical Image Processing Laboratory, located in the Medical School, is involved in research in image reconstruction methods and image analysis with applications to medical imaging. It is well equipped for high-speed computing with SUN-UNIX and Linux desktops as well as high-performance 20-node cluster.

The Fiber Optic Sensors Laboratory research emphasis is on the development and fabrication of novel fiber optic systems for very diverse applications ranging from aerospace to biomedical projects involving the development of new techniques and algorithms. Some of the current research projects include development of capillary waveguide based biosensors for detection of pathogens in a marine environment, integrated fiber optic-based systems for real-time detection of synchronous and asynchronous vibrations in turbomachinery, and single photon-based detection schemes for submicroscopic particle sizing. Equipment includes a diamond saw, fiber optic fusion splicer, fiber polisher, micropositioners, optical microscope, optical scanners, optical spectrometer (visible range), and various laser sources. Additionally, the laboratory has the facilities for designing printed circuits and fabricating optical and electronic subsystems.

The Parallel and Neural Processing Laboratory conducts research in various parallel and neural network applications. Current research projects include natural adaptive critic control, pattern recognitions, and Bayesian Neural Networks. It is equipped with Pentium PCs and Synapse3 parallel neural network processing boards.

The Petaflops Design Laboratory is a research facility equipped with two SUN workstations, several PCs with Linux, and a 16-processor Beowulf-type cluster. All computers are connected by Fast 100 Mb/sec Ethernet LAN.

The Semiconductor Optoelectronics Laboratory possesses the infrastructure for wafer processing, testing, and sophisticated characterization of optoelectronics devices. Processing facilities are based on a "Class 100" clean room with Darl Suss aligner, Temescal metal film deposition system, and other equipment required for modern semiconductor wafer processing. Wafer testing can be performed by low and high temperature probe-stations. Characterization of devices after processing includes electrical, optical, and spectral measurements. Electrical and optical measurements can be carried out within a wide frequency range from CW to 22GHz. Semiconductor laser near and far field emission patterns can be studied in a wide spectral range from visible to mid-infrared. Spectral analysis of radiation is performed with high resolution and sensitivity using grating and two Fourier transform spectrometers in combination with state-of-the-art detector systems. Time resolved luminescence experiments are available with ns resolution. The laboratory is equipped with 150fs Nd-glass mode locked laser for optical pumping as well as other pump sources including a high-energy Q-switched Nd solid-state laser. New experimental methods of studying semiconductor laser parameters, developed in the laboratory, include direct heterobarrier leakage current measurements as well as gain, loss, and alpha-factor measurements in broad area and single mode lasers.

Admission

For admission to graduate study in the Department of Electrical and Computer Engineering the minimum requirements are:

A. A bachelor's degree in electrical engineering from an accredited college or university; outstanding applicants in other technical or scientific fields will be considered, though special make-up coursework over and above the normal requirements for a graduate degree may be required;

B. A minimum grade point average of B in all courses in engineering, mathematics, and science;

C. Official results of the Graduate Record Examination (GRE) General Test;

D. Acceptance by both the Department of Electrical and Computer Engineering and the Graduate School.

Faculty

Distinguished Professors

Belenky, Gregory, Doctor of Physical and Mathematical Sciences, 1979, Institute of Physics, Baku, U.S.S.R.: Design, manufacturing, and characterization of optoelectronic and microelectronic semiconductor devices; physics of semiconductors and semiconductor devices.

Luryi, Serge, *Chair*, Ph.D., 1978, University of Toronto, Canada: Solid-state electronic devices.

Marsocci, Velio A., *Emeritus*, Eng.Sc.D., 1964, New York University: Solid-state electronics; integrated electronics; biomedical engineering.

Zemanian, Armen H., Eng.Sc.D., 1953, New York University: Network theory; computational methods; VLSI modeling.

Professors

Chang, Sheldon S.L., *Emeritus*, Ph.D., 1947, Purdue University: Optimal control; energy conservation; information theory; economic theory.

Chen, Chi-Tsong, Ph.D., 1966, University of California, Berkeley; CA systems and control theory.

Djuric, Petar M., Ph.D., 1990, University of Rhode Island: Signal processing; signal and systems modeling.

Parekh, Jayant P., Ph.D., 1971, Polytechnic Institute of Brooklyn: Microwave acoustics; microwave magnetics; microwave electronics; microcomputer applications.

Robertazzi, Thomas G., 1981, Princeton University: Computer communications; performance evaluation; parallel processing; e-commerce technology.

Shamash, Yacov, *Dean of the College of Engineering and Applied Sciences*, Ph.D., 1973, Imperial College of Science and Technology, England: Control system; robotics.

Short, Kenneth L., Ph.D., 1973, Stony Brook University: Digital system design; microprocessors; instrumentation.

Subbarao, Murali, Ph.D., 1986, University of Maryland: Machine vision; image processing; pattern recognition.

Tuan, Hang-Sheng, Ph.D., 1965, Harvard University: Electromagnetic theory; integrated optics; microwave acoustics.

Yang, Yuanyuan, *Graduate Program Director*, Ph.D., 1992, Johns Hopkins University: Wireless networks; optical networks; high-speed networks; parallel and distributed computing systems; multicast communication; high-performance computer architecture; and computer algorithms.

Associate Professors

Dhadwal, Harbans, Ph.D., 1980, University of London, England: Laser light scattering; fiber optics; signal processing and instrumentation.

Doboli, Alex, Ph.D., 2000, University of Cincinnati: VLSI CAD and design, synthesis and simulation of mixed analog-digital systems, hardware/software co-design of embedded systems, and high-level synthesis of digital circuits.

Dorojevets, Mikhail, Ph.D., 1988 Siberian Division of the U.S.S.R. Academy of Sciences, Novosibirsk: Computer architectures, systems design.

Gindi, Gene, Ph.D., 1981, University of Arizona: Medical image processing; image analysis.

Gorfinkel, Vera, Ph.D., 1980, A.F. Iaffe Physical-Technical Institute, St. Petersburg, Russia: Semiconductor devices, including microwave and optoelectronics; DNA sequencing instrumentation; single photon counting techniques.

Hong, Sangjin, Ph.D., 1999, University of Michigan: Low-power VLSI design of multimedia wireless communications and digital signal processing systems, including SOC design methodology and optimization.

Kamoua, Ridha, Ph.D., 1992, University of Michigan: Solid-state devices and circuits; microwave devices and integrated circuits.

Murray, John, Ph.D., 1974, University of Notre Dame: Signal processing; systems theory.

Sussman-Fort, Stephen E., Ph.D., 1978, University of California, Los Angeles: RF and microwave circuits; computer-aided circuit design; active and passive filters; classical network theory.

Tang, K. Wendy, Ph.D., 1991, University of Rochester: Interconnection networks, parallel computing, and neural networks.

Assistant Professors

Donetski, Dmitri, Ph.D., 2000, Stony Brook University: Design and technology of optoelectronic devices and systems including photovoltaic and photoconductive detectors, diode lasers and diode laser arrays.

Fernandez-Bugallo, Monica, Ph.D., 2001, Universidade da Coruna (Spain): Statistical signal processing with emphasis in the topics of Bayesian analysis, sequential Monte Carolo methods, adaptive filtering, and stochastic optimization.

Stanacevic, Milutin, Ph.D., 2005, Johns Hopkins University: Analog and mixed-signal VLSI integrated circuits and systems; adaptive microsystems; implantable electronics.

Shterengas, Leon, Ph.D., 2004, Stony Brook University: High-power and high-speed light emitters, carrier dynamics in nanostructures, molecular beam epitaxy of semiconductor nanostructures.

Wang, Xin, Ph.D., 2001, Columbia University, Mobile and ubiquitous computing, wireless communications and networks, grid and distributed computing, advanced applications and services over Internet and wireless networks.

Number of teaching, graduate, and research assistants, Fall 2005: 49

Degree Requirements

Requirements for the M.S. Degree

The M.S. degree in the Department of Electrical and Computer Engineering requires the satisfactory completion of a minimum of 30 graduate credits. These requirements may be satisfied by either one of the two following options:

I. M.S. Non-Thesis Option

A. At least 30 graduate credits with a cumulative and Departmental grade point average of 3.0 or better. Among these 30 credits, up to six credits may be ESE 597, ESE 599, or ESE 698.

B. Minimum of eight regular courses with at least a 3.0 grade point average. Of these eight, at least seven regular courses must be in the Department of Electrical and Computer Engineering; three of the seven must be selected from the following: ESE 502, ESE 503, ESE 511, ESE 520, ESE 528, ESE 545, ESE 554, or ESE 555.

C. ESE 597, ESE 599, ESE 698, and ESE 699 are not counted as regular courses in item B. Courses that permit repetitive credit, such as research seminars or special topics, can be counted only once (three or four credits) for item B. However, ESE 670 may be counted only once for regular course credit toward the M.S. degree, and ESE 698 may be counted only once (three credits) for credit toward the M.S. degree.

D. Up to 12 transfer credits may be applied toward the degree with the approval of the program committee.

II. M.S. Thesis Option

A. Students must inform the Department in writing at the end of their first semester if they choose the M.S. Thesis Option. At least 30 graduate credits with a cumulative and Departmental grade point average of 3.0. At least six credits of ESE 599. No more than a total of 12 credits may be taken from ESE 597, ESE 599, and ESE 698.

B. Minimum of six regular courses with at least a 3.0 grade point average. Of these six, at least four courses must be in the Department of Electrical and Computer Engineering. At least three of these four regular courses must be selected from the following: ESE 502, ESE 503, ESE 511, ESE 520, ESE 528, ESE 545, ESE 554, or ESE 555.

C. ESE 597, ESE 599, ESE 698, and ESE 699 are not counted as regular courses in item B. Courses that permit repetitive credit, such as research seminars or special topics, can be counted only once (three or four credits) for item B. However, ESE 670 may be counted only once for regular course credit toward the M.S. degree, and ESE 698 may be counted only once (three credits) for credit toward the M.S. degree.

D. Up to 12 transfer credits may be applied toward the degree with the approval of the program committee.

E. Satisfactory completion of a thesis.

Requirements for the Ph.D. Degree

A. Qualifying Examination

There is a major and minor part to the qualifying examination. The written examination is offered once every year in April. Students must pass one major written examination in two consecutive tries. The two consecutive tries do not need to be in the same area. The minor requirement can be satisfied by taking and passing a second major written examination or by taking three graduate courses in a different area than the major. Previous examinations are available in the Departmental office for review, however, students must make their own copies. Please refer to the Department's *Graduate Student Guide* for additional information on the qualifying examination.

B. Course Requirements

1. A minimum of six regular courses beyond the M.S. degree or 14 regular courses beyond the bachelor's degree. The choice must have the prior approval of the designated faculty academic advisor. ESE 697 Practicum in Teaching (three credits) is required to satisfy the teaching requirement. Students must be G-5 status to take this course. The courses ESE 597, ESE 598, ESE 599, ESE 698, and ESE 699 are not counted as regular courses. Courses presented under the title ESE 670 Topics in Electrical Sciences that have different subject matters, and are offered as formal lecture courses, are considered different regular courses but may not be counted more than once as a regular course for credit toward the M.S. degree, and not more than twice for all graduate degrees awarded by the Department of Electrical and Computer Engineering.

2. The student must satisfy the stipulations of a plan of study which must be filed with the graduate program committee within six months after the student passes the qualifying examination. The study plan, which will include the six regular courses as required in item 1, will be developed under the aegis of the designated faculty advisor (who may or may not be the eventual thesis advisor). Modification of the study plan may be made by the preliminary examination committee and at any later time by the thesis advisor. An up-to-date plan must always be placed on file with the graduate program committee each time a modification is made.

C. Preliminary Examination

A student must pass the preliminary examination not more than 18 months after passing the qualifying examination. Both a thesis topic and the thesis background area are emphasized.

D. Advancement to Candidacy

After successfully completing all requirements for the degree other than the dissertation, the student is eligible to be recommended for advancement to candidacy. This status is conferred by the Dean of the Graduate School upon recommendation from the chair of the Department. Students must advance one year prior to the dissertation defense.

E. Dissertation

The most important requirement for the Ph.D. degree is the completion of a dissertation, which must be an original scholarly investigation. The dissertation must represent a significant contribution to the scientific and engineering literature, and its quality must be compatible with the publication standards of appropriate and reputable scholarly journals.

F. Approval and Defense of Dissertation

The dissertation must be orally defended before a dissertation examination committee, and the candidate must obtain approval of the dissertation from this committee. The committee must have a minimum of four members (at least three of whom are faculty members from the Department), including the research advisor, at least one person from outside the Department, and a committee chair. (Neither the research advisor nor the outside member may serve as the chair). On the basis of the recommendation of this committee, the Dean of the College of Engineering and Applied Sciences will recommend acceptance or rejection of the dissertation to the Dean of the Graduate School. All requirements for the degree will have been satisfied upon the successful defense of the dissertation.

G. Residency Requirement

The student must complete two consecutive semesters of full-time graduate study. Full-time study is 12 credits per semester until 24 graduate credits have been earned. After 24 graduate credits have been earned, the student may take only nine credits per semester for full-time status.

H. Time Limit

All requirements for the Ph.D. degree must be completed within seven years after completing 24 credits of graduate courses in the Department.

Courses

ESE 501 System Specification and Modeling
A comprehensive introduction to the field of System-on-Chip design. Introduces basic concepts of digital system modeling and simulation methodologies. Various types of hardware description language (HDL) will be studied, including Verilog, VHDL, and SystemC. Topics include top-down and bottom-up design methodology, specification language syntax and semantics, RTL, behavioral and system-level modeling, and IP core development. Included are three projects on hardware modeling and simulation.
Fall, every year, 3 credits, ABCF grading

ESE 502 Linear Systems
Development of transfer matrices and state-space equations from the concepts of linearity, time-invariance, causality, and lumpedness. Op-amp circuit implementations. Solutions and equivalent state equations. Companion and modal forms. Stability and Lyapunov equations. Controllability, observability, and their applications in minimal realization, state feedback, and state estimators. Coprime fraction of transfer functions and their designs in pole-placement and model matching. Both the continuous-time and discrete-time systems will be studied.
Fall, 3 credits, ABCF grading

ESE 503 Stochastic Systems
Basic probability concepts and application. Probabilistic bounds, characteristic functions, and multivariate distributions. Central limit theorem, normal random variables, stochastic processes in communications, control, and other signal processing systems. Stationarity, ergodicity, correlation functions, spectral densities, and transmission properties. Optimum linear filtering, estimation, and prediction.
Fall, 3 credits, ABCF grading

ESE 504 Performance Evaluation of Communications and Computer Systems
Advanced scheduling theory, queuing models, and algorithms for communication and computer systems. Transient analysis and M/G/1 queue models. Networks of queues, mean value analysis, and convolution algorithms. Petri networks. Bursty and self-similar traffic. Divisible load theory for scheduling and parallel computer performance evaluation.
Spring, 3 credits, ABCF grading
May be repeated for credit

ESE 505 Wireless Communications
This course covers first-year graduate-level material in the area of wireless communications: Wireless channels, overview of digital communications and signal processing for wireless communications, voice and data applications, design basics for wireless modems, analysis of system issues like resource management and handoff, cellular and wireless LAN systems.
Fall or spring, every year, 3 credits, ABCF grading

ESE 506 Wireless Network
This course will examine the area of wireless networking and mobile computing, looking at the unique network protocol challenges and opportunities presented by wireless communications and host or router mobility. The course will give a brief overview of fundamental concepts in mobile wireless systems and mobile computing, it will then cover system and standards issues including second-generation circuit switched and third-generation packet switched networks, wireless LANs, mobile IP, ad-hoc networks, sensor networks, as well as issues associated with small handheld portable devices and new applications that can exploit mobility and location information. This is followed by several topical studies around recent research publications in mobile computing and wireless networking field. This course will make the system architecture and applications accessible to the electrical engineer.
Prerequisite: ESE 505 and ESE 546 or ESE 548 or permission of instructor
3 credits, ABCF grading
May be repeated once for credit

ESE 508 Analytical Foundations of Systems Theory
An exposition of the basic analytical tools for graduate study in systems, circuits, control, and signal processing. Sets and mappings, finite-dimensional linear spaces, metric spaces, Banach spaces, Hilbert spaces. The theory will be developed and exemplified in the context of systems applications such as nonlinear circuits, infinite networks, feedback control, signal restoration via projections, and optimal signal modeling.
Spring, 3 credits, ABCF grading

ESE 510 Electronic Circuits
This is a course in the design and analysis of analog circuits, both discrete and integrated. The first part of the course presents basic topics related to circuit analysis: laws, theorems, circuit elements and transforms. Fundamental semiconductor devices are introduced next. A number of aspects of circuit design beginning with basic device operation through the design of large analog functional blocks including amplifiers, oscillators, and filters are discussed. Cannot be used to fulfill any ESE degree requirements.
Fall, 3 credits, ABCF grading

ESE 511 Solid-State Electronics
A study of the electron and hole processes in solids leading to the analysis and design of solid-state electronic devices. Solutions to the Schrodinger representation of quantum effects, perturbation techniques. Simple band structure, effective mass theorem. Derivation and application of the Boltzman transport theory. Electrical and thermal conductivities of metals and of semiconductors, Hall effect, thermal effects, and their application to electronic devices. Properties of semiconductors and the theories underlying the characteristics of semiconductor devices.
Fall, 3 credits, ABCF grading

ESE 512 Bipolar Junction and Heterojunction Electronic Devices
A study of fundamental properties of homojunction and heterojunction semiconductor devices. Derivation of the characteristic equation for p-n junction diodes, for the bipolar junction transistor (BJT), and for the heterojunction bipolar transistor (HBT); the device parameters for low- and high-frequency operation, the effects on the device characteristics of fabrication methods and of structural arrangements. The development of the large-signal and small-signal equivalent circuits for the p-n diode and the BJT and HPT devices, with emphasis on models used in prevalent computer-aided analysis (e.g., SPICE). Consideration of the devices in integrated-circuit applications.
Spring, 3 credits, ABCF grading

ESE 514 MOS Transistor Modeling
An overview of the metal-oxide semiconductor (MOS) transistor and its models for circuit analysis. The course is modular in structure. In a common first part, CMOS fabrication, device structure, and operation are introduced. Starting from basic concepts of electrostatics, MOS field-effect transistor operation is presented in an intuitive fashion, and no advanced background in solid-state theory is required. Analytical models of increasing complexity and their SPICE Implementations are discussed. The second part of the course allows students to focus on their field of preference: device physics; digital circuits; analog circuits. The course includes a project in one of these subtopics.
Fall, 3 credits, ABCF grading

ESE 515 Quantum Electronics I
Physics of microwave and optical lasers. Topics include introduction to laser concepts; quantum theory; classical radiation theory; resonance phenomena in two-level systems; Block equations-Kramers-Kronig relation, density matrix; rate equation and amplification; CO_2 lasers; discharge lasers; semiconductor lasers.
Fall, 3 credits, ABCF grading

ESE 516 Integrated Electronic Devices and Circuits I
Theory and applications: elements of semiconductor electronics, methods of fabrication, bipolar junction transistors, FET, MOS transistors, diodes, capacitors, and resistors. Design techniques for linear digital integrated electronic components and circuits. Discussion of computer-aided design, MSI, and LSI.
Fall, 3 credits, ABCF grading

ESE 517 Integrated Electronic Devices and Circuits II
Theory and applications: elements of semiconductor electronics, methods of fabrication, bipolar junction transistors, FET, MOS transistors, diodes, capacitors, and resistors. Design techniques for linear digital integrated electronic components and circuits. Discussion of computer-aided design, MSI, and LSI.
Spring, 3 credits, ABCF grading

ESE 519 Semiconductor Lasers and Photodetectors
The course provides an introduction to performance, testing, and fabrication techniques for semiconductor lasers and photodetectors. The topics include fundamentals of laser and detector operation, devices band diagram, device characteristics, and testing techniques for analog and digital edge emitting and surface emitting lasers, avalanche and PIN photodetectors. Special attention is given to the design and working characteristics of transmitters and pumping lasers for telecommunication networks.
Prerequisite: B.S. in Physical Sciences or Electrical and Computer Engineering
3 credits, ABCF grading

ESE 520 Applied Electromagnetics
Wave phenomena and their importance in electromagnetic engineering. Harmonic waves. Phase and group velocities. Dispersive and nondispersive propagation. Transmission lines. Maxwell Equations. Uniform plane waves, waveguides, resonators. Scattering matrix theory. Introduction to antenna theory. Electrostatics and magnetostatics as special cases of Maxwell equations.
Spring, 3 credits, ABCF grading

ESE 521 Applied Optics
This course teaches students the fundamental techniques necessary for analyzing and designing optical systems. Topics include matrix methods for ray optics, fundamentals of wave optics, beam optics, Fourier optics, and electromagnetic optics. The latter part of the course will deal with optical activity in anisotropic media and include polarization and crystal optics, electro-optics, and acousto-optics.
3 credits, ABCF grading

ESE 522 Fiber Optic Systems
This course covers the essential components of a modern optical fiber communication system: (I) wave propagation in optical fiber waveguides, (II) transmitter design, (III) receiver design, (IV) single wavelength fiber-optic networks, and (V) wavelength division multiplexing networks.
Prerequisite: ESE 319
Fall, 3 credits, ABCF grading

ESE 524 Microwave Acoustics
Continuum acoustic field equations. Wave equation, boundary conditions, and Pointing vector. Waves in isotropic elastic media: plane-wave modes, reflection and refraction phenomena, bulk-acoustic-wave (BAW) waveguides, surface acoustic waves (SAW). Plane and guided waves in piezoelectric media. BAW transduction and applications: delay-line and resonator structures, the Mason equivalent circuit, monolithic crystal filters, IM CON dispersive delay lines, acoustic microscopes, SAW transduction and applications: the interdigital transducer, band-pass filters, dispersive filters, convolvers, tapped delay lines, resonators.
Prerequisite: ESE 319
Fall, 3 credits, ABCF grading

ESE 526 Silicon Technology for VLSI
This course introduces the basic technologies employed to fabricate advanced integrated circuits. These include epitaxy, diffusion, oxidation, chemical vapor deposition, ion implantation lithography and etching. The significance of the variation of these steps is discussed with respect to its effect on device performance. The electrical and geometric design rules are examined together with the integration of these fabrication techniques to reveal the relationship between circuit design and the fabrication process.
Fall, 3 credits, ABCF grading

ESE 527 Circuit Theory and Applications
Foundation of design procedures for electric circuits. Fundamental concepts, graph theory, network equations, network functions, state equations, network synthesis, scattering parameters, nonlinear circuits.
Fall, 3 credits, ABCF grading

ESE 528 Communication Systems
This course provides a general overview of communication theory and addresses fundamental concepts in this field. After a review of signals and systems representations, various continuous and digital modulation schemes are analyzed. Spread spectrum systems and their application to multiuser communications are also addressed. Advanced communication systems are described and general concepts of wide and local area networks are introduced.
Fall, 3 credits, ABCF grading
May be repeated for credit

ESE 529 Electrical Network Theory
Linear and nonlinear electrical networks; graph theory; determination of operating points; transient estimation; interconnection networks; numerical methods; parameter extraction; infinite and transfinite networks; discrete potential theory; random walks on networks.
Spring, 3 credits, ABCF grading

ESE 530 Computer-Aided Design
The course presents techniques for analyzing linear and nonlinear dynamic electronic circuits using the computer. Some of the topics covered include network graph theory, generalized nodal and hybrid analysis, companion modeling. Newton's method in n-dimensions and numerical integration.
Prerequisite: B.S. in Electrical Engineering
Spring, 3 credits, ABCF grading

ESE 531 Detection and Estimation Theory
Hypothesis testing and parameter estimation. Series representation of random processes. Detection and estimation of known signals in white and nonwhite Gaussian noise. Detection of signals with unknown parameters.
Prerequisite: ESE 503 or permission of instructor
Spring, 3 credits, ABCF grading

ESE 532 Theory of Digital Communication
Optimum receivers, efficient signaling, comparison classes of signaling schemes. Channel capacity theorem, bounds on optimum system performance, encoding for error reduction, and the fading channel. Source coding and some coding algorithms.
Prerequisite: ESE 503
Fall, 3 credits, ABCF grading

ESE 535 Information Theory and Reliable Communications
Measures of information: entropy, relative entropy, and mutual information. The asymptotic equipartition property. Lossless source coding: Kraft inequality and the source coding theorem. Introduction to error correcting codes. Continuous and waveform channels. Rate-distortion theory.
Prerequisite: ESE 503 or equivalent or permission of instructor
Spring, 3 credits, ABCF grading

ESE 536 Switching and Routing in Parallel and Distributed Systems
This course covers various switching and routing issues in parallel and distributed systems. Topics include message switching techniques, design of interconnection networks, permutation, multicast, and all-to-all routing in various networking nonblocking, and rearrangable capability analysis and performance modeling.
Prerequisite: ESE 503 and 545 or CSE 502 and 547, or permission of instructor
3 credits, ABCF grading

ESE 540 Reliability Theory
Theory of reliability engineering. Mathematical and statistical means of evaluating the reliability of systems of components. Analytical models for systems analysis, lifetime distributions, repairable systems, warranties, preventive maintenance, and inspection. Software reliability and fault tolerant computer systems.
Prerequisite: ESE 503 or permission of instructor
3 credits, ABCF grading

ESE 541 Digital System Design
The course provides an introduction to digital and computer systems. The course follows a top-down approach to presenting design of computer systems, from the architectural-level to the gate-level. VHDL language is used to illustrate the discussed issues. Topics include design hierarchy and top-down design; introduction to hardware description languages; computer-aided design and digital synthesis; basic building blocks like adders, comparators, multipliers, latches, flip-flops, registers etc.; static and dynamic random access memory; data and control buses; fundamental techniques for combinational circuit analysis and design; sequential circuit design procedures; and programmable logic devices. Testing of digital designs is addressed throughout the course. A mini-project will complement the course. Cannot be used to fulfill any ESE degree requirements.
Prerequisites: B.S. in Engineering, but not EE, CE, or CS.
Spring, 3 credits, ABCF grading

ESE 542 Product Design Concept Development and Optimization
This graduate course will concentrate on the design concept development of the product development cycle, from the creative phase of solution development to preliminary concept evaluation and selection. The course will then cover methods for mathematical modeling, computer simulation, and optimization. The concept development component of the course will also cover intellectual property and patent issues. The course will not concentrate on the development of any particular class of products, but the focus will be mainly on mechanical and electromechanical devices and systems. As part of the course, each participant will select an appropriate project to practice the application of the material covered in the course and prepare a final report.
Prerequisites: Undergraduate electrical or mechanical engineering and/or science training
Fall, 3 credits, ABCF grading

ESE 544 Network Security
An introduction to computer network and telecommunication network security engineering. Special emphasis on building security into hardware and hardware working with softeware. Topics include encryption, public key cryptography, authentication, intrusion detection, digital rights management, firewalls, trusted computing, encrypted computing, intruders, and viruses. Some projects.
Fall, alternate years, 3 credits, ABCF grading

ESE 545 Computer Architecture
The course covers uniprocessor and pipelined vector processors. Topics include: hierarchical organization of a computer system; processor design; control design; memory organization and virtual memory; I/O systems; balancing subsystem bandwidths; RISC processors; principles of designing pipelined processors; vector processing on pipelines; examples of pipelined processors. The course involves a system design project using VHDL.
Prerequisite: ESE 318 or equivalent
Spring, 4 credits, ABCF grading

ESE 546 Computer Communications Network
An introduction to the quantitative and qualitative aspects of telecommunication networks. Continuous time and discrete time single queue system analysis. Data link, network, and transport protocols layers. Network interconnection. Multiple access techniques. Flow and congestion control. High-speed switching.
Prerequisite: ESE 503 or permission of instructor
Fall, 3 credits, ABCF grading

ESE 547 Digital Signal Processing
A basic graduate course in digital signal processing. Sampling and reconstruction of signals. Review of Z-Transform theory. Signal flow-graphs. Design of FIR and IIR filters. Discrete and fast Fourier transforms. Introduction to adaptive signal processing. Implementation considerations.
Prerequisite: Senior-level course in signals and systems
Fall, 3 credits, ABCF grading

ESE 548 Local and Wide Area Networks
Extended coverage of specific network protocols. Protocols covered include IEEE 802 local area network protocols. Asynchronous Transfer Mode (ATM), Synchronous optical Network (SONET), metropolitan area network protocols, backbone packet switching protocols, and transport control protocol/Internet protocol (TCP/IP), network security, Web server design, and grid computing.
Prerequisite: ESE 546 or permission of instructor
Summer, 3 credits, ABCF grading

ESE 549 Advanced VLSI System Testing
This course is designed to acquaint students with fault diagnosis of logic circuits. Both combinatorial and sequential circuits are considered. Concepts of faults and fault models are presented. Emphasis is given to test generation, test selection, fault detection, fault location, fault location within a module, and fault correction.
Prerequisite: B.S. in Electrical Engineering
Spring, 3 credits, ABCF grading

ESE 550 Network Management and Planning
This course provides an introduction to telecommunications and computer network management and planning. Network management is concerned with the operation of networks while network planning is concerned with the proper evolution of network installations over time. Network management topics include meeting service requirements, management operations, management interoperability, and specific architectures such as Telecommunications Management Network (TMN), and Simple Network Management Protocol (SNMP). Network planning topics include planning problem modeling, topological planning design, heuristic and formal solution techniques.
Fall, 3 credits, ABCF grading

ESE 551 Switching Theory and Sequential Machines
Survey of classical analysis and synthesis of combination and sequential switching circuits, followed by related topics of current interest such as error diagnosis and fail soft circuits, use of large-scale integration, logic arrays, automated local design.
Prerequisite: ESE 318 or equivalent
Fall, 3 credits, ABCF grading

ESE 552 Interconnection Networks
Formation and analysis of interconnect processing elements in parallel computing organization. Topics include: SIMD/MIMD computers, multiprocessors, multicomputers, density, symmetry, representations, and routing algorithms. Topologies being discussed include: Benes, Omega, Banyan, mesh, hypercube, cube-connected cycles, generalized chordal rings, chordal rings, DeBruijn, Moebius graphs, Cayley graphs, and Borel Cayley graphs.
Prerequisite: ESE 545 or equivalent
Fall, 3 credits, ABCF grading

ESE 553 A/D and D/A Integrated Data Converters
This is an advanced course on analog integrated circuit design aspects for data converters. Topics include: continuous and discrete-time signals and systems; sampling theorem; ideal ND and D/A converters; specifications and testing of data converters; basic building blocks in data converters: current sources and mirrors, differential gain stages, voltage references, S/H circuits, comparators: Nyquist D/A and ND converters: principles of data conversion and circuit design techniques; oversampling data converters: low-pass and band-pass delta-sigma modulators, decimation and interpolation for delta-sigma data converters. The attending students must be acquainted with principles of transistor operation, function of simple analysis. Familiarity with SPICE is required.
3 credits, ABCF grading

ESE 554 Computational Models for Computer Engineers
This course covers mathematical techniques and models used in the solution of computer engineering problems. The course heavily emphasizes computer engineering application. Topics covered include set theory, relations, functions, graph theory and graph algorithms, and algebraic structures.
Fall, 3 credits, ABCF grading

ESE 555 Advanced VLSI Systems Design
Techniques of VLSI circuit design in the MOS technology are presented. Topics include MOS transistor theory, CMOS processing technology, MOS digital circuit analysis and design, and various CMOS circuit design techniques. Digital systems are designed and simulated throughout the course using an assortment of VLSI design tools.
Prerequisite: B.S. in Electrical Engineering or Computer Science
Spring, 3 credits, ABCF grading

ESE 556 VLSI Physical and Logic Design Automation
Areas to be covered are physical design automation and logic design automation. Upon completion of this course, students will be able to develop state-of-the art CAD tools and algorithms for VLSI logic and physical design. Tools will address design tasks such as floor planning, module placement, and signal routing. Also, automated optimization of combinational and sequential circuits will be contemplated.
Prerequisite: B.S. in Computer Engineering/Science or Electrical Engineering
Fall, 3 credits, ABCF grading

ESE 557 Digital Signal Processing II: Advanced Topics
A number of different topics in digital signal processing will be covered, depending on class and current research interest. Areas to be covered include the following: parametric signal modeling, spectral estimation, multirate processing, advanced FFT and convolution algorithms, adaptive signal processing, multidimensional signal processing, advanced filter design, dedicated signal processing chips, and signal processing for inverse problems. Students will be expected to read and present current research literature.
Prerequisite: ESE 547 or permission of instructor
Spring, 3 credits, ABCF grading

ESE 558 Digital Image Processing I
Covers digital image fundamentals, mathematical preliminaries of two-dimensional systems, image transforms, human perception, color basics, sampling and quantization, compression techniques, image enhancement, image restoration, image reconstruction from projections, and binary image processing.
Prerequisite: B.S. in Engineering or Physical or Mathematical Sciences
Fall, 3 credits, ABCF grading

ESE 559 Digital Image Processing II
The course material will proceed directly from DIP-I, starting with image reconstruction from projections. After the basic projection, theorems are developed and computerized axial tomography techniques will be examined in detail including forward and inverse random transformations, convolution, back projection, and Fourier reconstruction; nuclear magnetic resonance imaging and positron emission tomography will be similarly covered. Surer resolution concepts will be developed and applied to a variety of remote sensing applications as well as digital image coding for efficient transmission of digital TV imagery.
Prerequisite: ESE 558
Spring, 3 credits, ABCF grading

ESE 560 Optical Information Processing
The course is designed to give the student a firm background in the fundamentals of optical information processing techniques. It is assumed that the student is familiar with Fourier transforms and complex algebra, and is conversant with the principles of linear system theory. The course begins with a mathematical introduction to linear system theory and Fourier transformation. The body of the course is concerned with the scalar treatment of diffraction and its application to the study of optical imaging techniques and coherent and incoherent optical processors.
Prerequisite: B.S. in Physical Sciences
Spring, 3 credits, ABCF grading

ESE 563 Fundamentals of Robotics I
This course covers homogenous transformations of coordinates; kinematic and dynamic equations of robots with their associated solutions; control and programming of robots.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading

ESE 565 Parallel Processing Architectures
This course provides a comprehensive intro-

duction to parallel processing. Topics include types of parallelism, classification of parallel computers, functional organizations, interconnection networks, memory organizations, control methods, parallel programming, parallel algorithms, performance enhancement techniques and design examples for SIMD array processors, loosely coupled multiprocessors, and tightly coupled multiprocessors. A brief overview of dataflow and reduction machines will also be given.
Prerequisite: ESE 545 or equivalent
Spring, 3 credits, ABCF grading

ESE 566 Hardware-Software Co-Design of Embedded Systems
This course will present state-of-the-art concepts and techniques for design of embedded systems consisting of hardware and software components. Discussed topics include system specification, architectures for embedded systems, performance modeling and evaluation, system synthesis and validation. The course is complemented by three mini-projects focused on designing and implementing various co-design methods.
Prerequisites: ESE 333, ESE 345 or equivalent
Fall, 3 credits, ABCF grading

ESE 568 Computer and Robot Vision
Principles and applications of computer and robot vision are covered. Primary emphasis is on techniques and algorithms for 3-D machine vision. The topics include image sensing of 3-D scenes, a review of 2-D techniques, image segmentation, stereo vision, optical flow, time-varying image analysis, shape from shading, texture, depth from defocus, matching, object recognition, shape representation, interpretation of line drawings, and representation and analysis of 3-D range data. The course includes programming projects on industrial applications of robot vision.
Prerequisite: B.S. in Engineering or Physical or Mathematical Sciences
3 credits, ABCF grading

ESE 570 Bioelectronics
Origin of bioelectric events; ion transport in cells; membrane potentials; neural action potentials and muscular activity; cortical and cardiac potentials. Detection and measurement of bioelectric signals; impedance measurements used to detect endocrine activity, perspiration, and blood flow; impedance cardiography; vector cardiography; characteristics of transducers and tissue interface; special requirements for the amplification of transducer signals.
Fall, 3 credits, ABCF grading

ESE 571 Introduction to Auto ID Technologies
This new introductory course is a series of Auto ID systems, technologies, and applications. The course covers theory and applications of important data-capture technologies, namely, barcodes, biometrics, and RFID. Topics to be covered include: architecture of data-capture/Auto ID systems, barcodes: overview of 1-D and 2-D barcodes and other LOS technologies; biometrics: fingerprints, iris-scan, voice recognition, and smart-cards; radio frequency identification (RFID): fundamentals, near-field vs. far-field, UHF read range estimation, reader sensitivity limits, tag singulation and multiple access protocols, standards, privacy and security issues in RFID, real-time location systems (RTLS), and wireless sensor networks.
Prerequisites: ESE 372, ESE 218, ESE 305 (ESE 319)
3 credits, ABCF Grading

ESE 575 Advanced VLSI Signal Processing Architecture
This course is concerned with advanced aspects of VLSI architecture in digital signal processing and wireless communications. The first phase of the course covers the derivation of both data transformation and control sequencing from a behavioral description of an algorithm. The next phase reviews the general purpose and dedicated processor for signal processing algorithms. This course focuses on low-complexity high-performance algorithm development and evaluation, system architecture modeling, power-performance tradeoff analysis. The emphasis is on the development of application-specific VLSI architectures for current and future generation of wireless digital communication systems. An experimental/ research project is required.
Prerequisite: ESE 355 or equivalent, ESE 305 or ESE 337 or equivalent, ESE 306 or ESE 340 or equivalent, ESE 380 or equivalent
3 credits, ABCF grading

ESE 580 Microprocessor-Based Systems Engineering I
This course is a study of methodologies and techniques for the engineering design of microprocessor-based systems. Emphasis is placed on the design of reliable industrial quality systems. Diagnostic features are included in these designs. Steps in the design cycle are considered. Specifically, requirement definitions, systematic design implementation, testing, debugging, documentation, and maintenance are covered. Laboratory demonstrations of design techniques are included in this course. The students also obtain laboratory experience in the use of microprocessors, the development of systems, circuit emulation, and the use of signature and logic analyzers.
Fall, 4 credits, ABCF grading

ESE 581 Microprocessor-Based Systems Engineering II
This course is a study of methodologies and techniques for the engineering design of microprocessor-based systems. Emphasis is placed on the design of reliable industrial quality systems. Diagnostic features are included in these designs. Steps in the design cycle are considered. Specifically, requirement definitions, systematic design implementation, testing, debugging, documentation, and maintenance are covered. Laboratory demonstrations of design techniques are included in this course. The students also obtain laboratory experience in the use of microprocessors, the development of systems, circuit emulation, and the use of signature and logic analyzers.
Spring, 4 credits, ABCF grading

ESE 588 Pattern Recognition
Basic concepts of pattern recognition techniques are introduced, including statistical pattern recognition, syntactic pattern recognition, and graph matching. Topics on Bayes decision theory, parametric and nonparametric techniques, clustering techniques, formal languages, parsing algorithms, and graph-matching algorithms are covered.
Prerequisite: Stochastic processes and data structures
Spring, 3 credits, ABCF grading

ESE 591 Industrial Project in OEMS Engineering
A student carries out a detailed design of an industrial project in OEMS engineering. A comprehensive technical report of the project and an oral presentation are required.
Fall, 3 credits, ABCF grading

ESE 597 Practicum in Engineering Internship
This course is for part-time and full-time graduate students, relating to their current professional activity. Participation is in private corporations, public agencies, or non-profit institutions. Students will be required to have a faculty advisor as well as a contact in the outside organization to participate with them in regular consultations on their project. Students are required to submit a final written report to both. The maximum credit that can be accepted toward the M.S. degree is three.
Fall, spring, and summer, 1-3 credits, S/U grading
May be taken only once

ESE 599 Research Master's Students
Fall and spring, 1-12 credits, S/U grading
May be repeated for credit

ESE 610 Seminar in Solid-State Electronics
Current research in solid-state devices and circuits and computer-aided network design.
Fall and spring, 3 credits, ABCF grading

ESE 670 Topics in Electrical Sciences
Varying topics selected from current research topics. This course is designed to give the necessary flexibility to students and faculty to introduce new material into the curriculum before it has attracted sufficient interest to be made part of the regular course material. Topics include biomedical engineering, circuit theory, controls, electronics circuits, digital systems and electronics, switching theory and sequential machines, digital signal processing, digital communications, computer architecture, networks, systems theory, solid-state electronics, integrated electronics, quantum electronics and lasers, communication theory, wave propagation, integrated optics, optical communications and information processing, instrumentation, and VLSI computer design and processing.
Fall and spring, 3 credits, ABCF grading
May be repeated for credit

ESE 691 Seminar in Electrical Engineering
This course is designed to expose students to the broadest possible range of the current activities in electrical engineering. Speakers from both on and off campus discuss topics of current interest in electrical engineering.

Fall and spring, 1 credit, S/U grading
May be repeated for credit

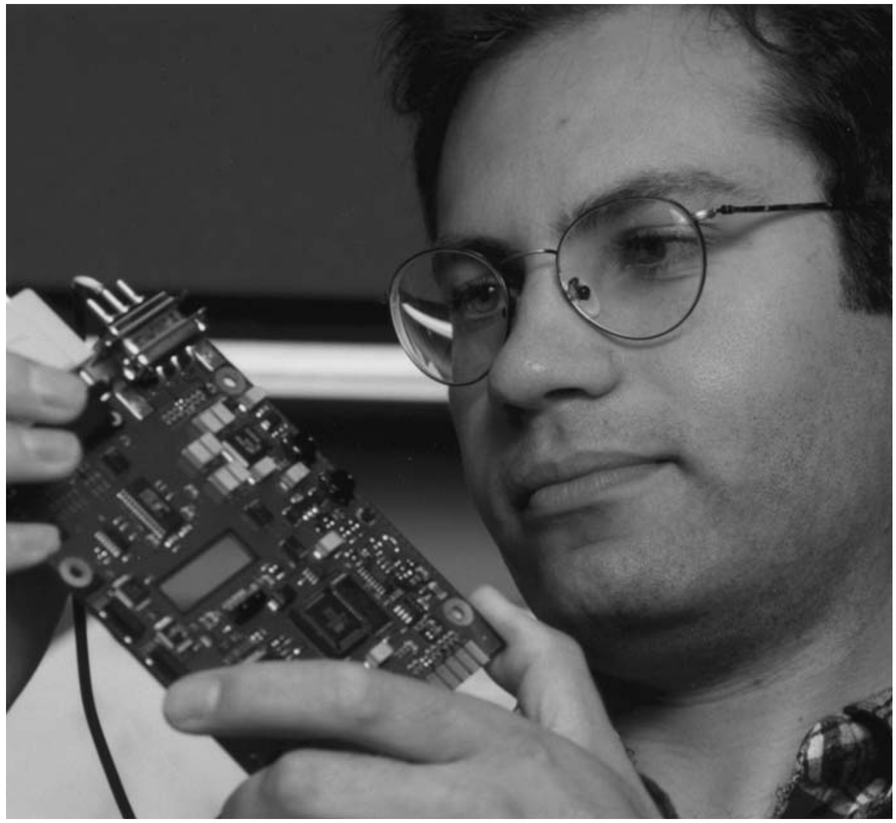
ESE 697 Ph.D. Practicum in Teaching
The course provides hands-on experience in classroom teaching. Other activities may include preparation and supervision of laboratory experiments, exams, homework assignments and projects. Final report that summarizes the activities and provides a description of the gained experience and a list of recommendations is required.
Prerequisite: G5 status and permission of graduate program director
Fall and spring, 3 credits, ABCF grading

ESE 698 Practicum in Teaching
This course enables graduate students to gain experience in teaching and interacting with students enrolled in an Electrical and Computer Engineering courses. Students enrolled in ESE 698 are expected to perform various teaching duties required by the course instructor, such as attending lectures, providing office hours, holding review/recitation sessions, assisting in lab sections, grading, etc.
Fall, spring, and summer, 1-3 credits, ABCF grading
May be repeated for credit

ESE 699 Dissertation Research On Campus
Prerequisite: Advancement to candidacy (G5); major portion of research must take place on SB campus, at Cold Spring Harbor, or at Brookhaven National Lab
Fall, spring, and summer, 1-9 credits, S/U grading
May be repeated for credit

ESE 700 Dissertation Research Off Campus–Domestic
Prerequisite: Must be advanced to candidacy (G5); major portion of research will take place off campus, but in the U.S. and/or U.S. provinces (Brookhaven National Lab and Cold Spring Harbor Lab are considered on campus); all international students must enroll in one of the graduate student insurance plans and should be advised by an International Advisor
Fall, spring, and summer, 1-9 credits, S/U grading
May be repeated for credit

ESE 701 Dissertation Research Off Campus–International
Prerequisite: Must be advanced to candidacy (G5); major portion of research will take place outside the U.S. and/or U.S. provinces; domestic students have the option of the health plan and may also enroll in MEDEX; international students who are in their home country are not covered by mandatory health plan and must contact the Insurance Office for the insurance charge to be removed; international students who are not in their home country are charged for the mandatory health insurance (if they are to be covered by another insurance plan, they must file a waiver by the second week of classes; the charge will only be removed if the other plan is deemed comparable); all international students must receive clearance from an International Advisor
Fall, spring, and summer, 1-9 credits, S/U grading
May be repeated for credit



ESE 800 Full Time Summer Research
0 credits, S/U grading
May be repeated