MASTER OF SCIENCE IN ELECTRICAL AND COMPUTER ENGINEERING

Electrical and Computer Engineering at Fairfield University is an interdisciplinary program that enables students to study in several fields including (but not limited to) engineering, mathematics, science, computer hardware, computer software, power, VLSI, sensors, mixed signals, measurement, controls, biomedical, nanotechnology and business. Each student can establish a unique educational identity .

The MSECE graduate student can obtain a leadership position in a high-technology industry. In a time when the ability to innovate is the only sustainable competitive advantage, an ECE degree unlocks the door to an entrepreneurial career. Our graduates work to design and build state-of-the-art products and are highly sought after by employers.

Students may take elective courses in mechanical engineering, software engineering and management of technology. As a consequence, students gain technical skills and a sense of the economic and business values needed to employ technology to serve society's needs. Some of our students have selected to participate in business plan competitions and engage in engineering entrepreneurship. We have strong ties to the Inventors Association of Connecticut, the Technology Venture community and local industry.

Program Overview

The MSECE program provides students with the knowledge and skills to innovate and lead in their discipline in the framework of research and development in academic institutions, the industrial workplace, research laboratories, or service organizations. The basic objectives of the MSECE program include the following:

1. Students receive the tools they need to take the lead in creating next generation technologies using fundamental design disciplines. Sequences of electives, as well as a master's thesis (optional), provide depth in their learning experiences.
2. Students gain exposure to the high-tech areas of electrical and computer engineering, including systems and product engineering, hardware and software design, embedded systems, communication systems, control systems, computer architecture, and visualization and multimedia systems. Students have the opportunity to become skilled in creating unique object-oriented designs. State of the art facilities available in the School of Engineering and Computing, and close interactions with industry, assist in those tasks.
3. The MSECE program provides undergraduate students with the opportunity to pursue a graduate degree program that broadens their career path, ultimately leading to leadership roles.

Students

Electrical and computer engineering embodies the science and technology of design, implementation, and maintenance of software and hardware components of modern electrical, electronics, computing and network systems. This discipline has emerged from the traditional fields of electrical engineering and computer science. Hence, the student population for the program has several origins. Typical examples include the following:

1. Engineers and scientists who, responding to the specific needs of their industry across the spectrum of electrical and computer engineering domains, need to acquire skills to effectively guide the development of technologies that will enhance product quality and business opportunities
2. Engineers and scientists who wish to fulfill their needs for personal and professional growth and achieve entrepreneurship in the IT domains
3. Engineers aspiring to a career change
4. Undergraduate engineering students and alumni with B.S. degrees, who seek an opportunity to continue their studies for a graduate engineering degree at Fairfield University.

Graduates

Graduates are employed in several industries, including the computer, aerospace, telecommunications, power, manufacturing, defense, and electronics industries. They can expect to design high-tech devices ranging from tiny microelectronic integrated-circuit chips to powerful systems that use those chips, and efficient interconnected telecommunication systems. Applications include consumer electronics; advanced microprocessors; peripheral equipment; systems for portable, desktop, and client/server computing; communications devices; distributed computing environments such as local and wide area networks, wireless networks, Internets, Intranets; embedded computer systems; and a wide array of complex technological systems such as power generation and distribution systems and modern computer-controlled processing and manufacturing plants.

Program

Prerequisites and Foundation Competencies

Students entering the program without an appropriate background in electrical or computer engineering may have to take additional bridge courses as prescribed during the admissions decision, in order to prepare for the advanced coursework required at the Master's level.

Program Requirements

Students in the MSECE program must complete 30 credits, with either a thesis option or with a non-thesis option. Students take one required course along with 12 credits of electives in ECE for the thesis option and 18 credits of ECE electives for the non-thesis option. Students take approved Engineering, Math, or Business graduate courses for the remaining credits. Several electives are available to students across several areas of specialization. Upon admission, students meet with an advisor to prepare a plan of study that will lead to a master's degree in electrical and computer engineering in the most expeditious manner while meeting the student's professional needs.

Thesis Option

Code	Title	Credits
ECEG 5415	Engineering Applications of Numerical Methods	3
ECEG 6971	Thesis I	3
ECEG 6972	Thesis II	3
Select 4 elective courses from ECE [1]		12

Select 3 elective courses from approved Engineering, Math, or Business graduate courses	9
Total Credits	**30**

Non-Thesis Option

Code	Title	Credits
ECEG 5415	Engineering Applications of Numerical Methods	3
Select 6 elective courses from ECE [1]		18
Select 3 elective courses from approved Engineering, Math, or Business graduate courses		9
Total Credits		**30**

[1] Electives may be chosen from courses listed under Electrical and Computer Engineering, as well as ECEG 5990 Independent Study, or any other graduate-level engineering, math, or business course, under advisement of the department chair or academic advisor.

ECE Elective Domains

Code	Title	Credits
Power and Energy		
ECEG 5361	Green Power Generation	3
ECEG 5377	Power Security and Reliability	3
ECEG 5385	Power Generation and Distribution	3
ECEG 5386	Fault Analysis in Power Systems	3
ECEG 5505	Advanced Power Electronics	3
Communications Systems		
ECEG 5379	Communication Systems	3
ECEG 5480	Wireless Systems I	3
Electronic Systems		
ECEG 5315	Nanoelectronics I	3
ECEG 5323	Thermal Management of Microdevices	3
ECEG 5335	Microelectronics	3
ECEG 5336	Analog Electronics Design	3
ECEG 5355	Sensor Design and Application	3
ECEG 5378	Electromagnetic Compatibility	3
ECEG 5405	Electronic Materials	3
ECEG 5510L	Product Design Lab	1
ECEG 5520L	System Design Lab	1
Computer Engineering		
ECEG 5303	Industrial Automation	3
ECEG 5325	Computer Graphics	3
ECEG 5334	Unmanned Aerial Vehicles: Design, Navigation, and Control	3
ECEG 5346	Computer Systems Architecture	3
ECEG 5406	Advanced Digital Design	3
ECEG 5460	Network Programming	3
ECEG 5365	Internet of Things	3
ECEG 5470	Network Embedded Systems	3
Biomedical Engineering		
ECEG 5309	Biosensors	3
ECEG 5311	Biomaterials	3
ECEG 5314	Introduction to Molecular Modeling	3
ECEG 5331	Biomedical Signal Processing	3
ECEG 5332	Biomedical Imaging	3
ECEG 5333	Biomedical Visualization	3
ECEG 5375	Bioelectronics	3
ECEG 5387	Instrumental Analysis in Biomedical Engineering	3
ECEG 5407	Computational Genomics	3

Plan of Study

Deviations from the required course list are permitted as a part of an advisor approved plan of study. Students must have an approved plan of study by the end of their first term. A plan of study may be changed at any time, with advisor approval.

Courses

ECEG 5260 Robots **3 Credits**

Introductory course in robotics develops understanding of how robotic systems integrate sensors, actuators, and control systems to achieve specific goals. Principles of autonomy, programming, wireless communications, sensor applications, mechatronics, electrical power, electric motors, pneumatics, structure, and locomotion will be understood and applied. Design of robotic subsystems will utilize multiple areas of knowledge. Students will understand degrees of freedom of a robotic arm and their safety parameters through demonstration and use of Fanuc Robot. Service learning is an integral part of the course. All students will participate in mentoring of youth to put into practice the principles learned in class, and gain communication skills through community interaction. Particularly they will participate in mentoring to build small robots to accomplish different feats, for example obstacle avoidance by a mobile robot.

ECEG 5303 Industrial Automation **3 Credits**

This course will give students an understanding of industrial automation concepts in the areas of process control, manufacturing, material handling, and others. Topics covered include sequential control, ladder logic, PLC systems and programming; industrial sensors; feedback control systems, PID and advanced control algorithms; distributed control systems, industrial networking, including network types and standards. Practical implementation of typical systems is discussed. The course will consist of lectures, case studies, and lab exercises. Advanced Topics are assigned. Undergraduate equivalent: ENGR 4303.

ECEG 5309 Biosensors **3 Credits**

This course will provide an overview of biosensors, including their use in pharmaceutical research, diagnostic testing, and policing the environment. Topics include the fabrication, characterization, testing, and simulation of biosensors. The phenomenon of transducers, biosensor structure, sensor performance, and simulations utilizing molecular simulation software will also be covered.

ECEG 5311 Biomaterials **3 Credits**
This course will cover the introductory level of understanding on the different types of biomaterials used in biomedical industry, their design and synthesis. Examples include implants, stents, catheters, smart polymer gels, bone grafts, and tissue scaffolds. Modern biology in biomedical engineering such as but not limited to protein adsorption, immuno-isolation, and regenerative medicine will be covered. Ethical issues in biomedical engineering will also be discussed. Current innovative research on nano-biotechnology that extends to 3D bio-matrix, advanced diagnostics, dental composites, sealants, and adhesives. Undergraduate equivalent: BIEG 4311.

ECEG 5314 Introduction to Molecular Modeling **3 Credits**
This course will cover methodological and practical aspects of the application of system analysis and computational tools to biological and biomedical problems. It will cover computational modeling of biological macromolecules such as proteins, DNA, and synthetic self-assembling materials such as polymers, crystals, colloids, and amphiphiles. The course provides the resources to use Visual Molecular Dynamics (VMD) and Nanoscale Molecular Dynamics (NAMD) to solve computational problems related to protein interactions in case of diseases and protein folding. Undergraduate equivalent: BIEG 4314.

ECEG 5315 Nanoelectronics I **3 Credits**
Building on the two introductory courses in nanotechnology, this course is the first of two that describe how nanotechnology can be integrated into the electronics industry. The unique electrical, mechanical, and optical properties of structures in the nanometer range and how they may be applied to electronics products are discussed. Principles of electronic materials, semiconductor devices, and microfabrication techniques will be extended to the nanoscale. Students will increase their knowledge of electronic structure, quantum mechanics, and the behavior of optoelectronic and low-dimensional systems. Students make extensive use of the available literature to seek out potential applications of nanotechnology. Undergraduate equivalent: ELEG 4315.

ECEG 5323 Thermal Management of Microdevices **3 Credits**
This course addresses the thermal design in electronic assemblies which includes thermal characteristics, heat transfer mechanisms and thermal failure modes. Thermal design of electronic devices enables engineers to prevent heat-related failures, increase the life expectancy of the system, and reduce emitted noise and energy consumption. This course provides the required knowledge of heat transfer for such analysis and various options available for thermal management of electronics. This course also presents advanced methods of removing heat from electronic circuits, including heat pipes, liquid immersion and forced convection.

ECEG 5325 Computer Graphics **3 Credits**
This course supports the visualization and computer systems domain with computer gaming applications. It is an introduction to GUI and game design and computer graphics concepts. Topics include human-computer interfaces using the AWT; applied geometry; homogeneous coordinate transforms. Undergraduate equivalent: CPEG 4325.

ECEG 5331 Biomedical Signal Processing **3 Credits**
This course presents an overview of different methods used in biomedical signal processing. Signals with bioelectric origin are given special attention and their properties and clinical significance are reviewed. In many cases, the methods used for processing and analyzing biomedical signals are derived from a modeling perspective based on statistical signal descriptions. The purpose of the signal processing methods ranges from reduction of noise and artifacts to extraction of clinically significant features. The course gives each participant the opportunity to study the performance of a method on real, biomedical signals. Undergraduate equivalents: BIEG 3331, CPEG 3331.

ECEG 5332 Biomedical Imaging **3 Credits**
Prerequisite: ECEG 5331.
The course presents the fundamentals and applications of common medical imaging techniques, for example: x-ray imaging and computed tomography, nuclear medicine, magnetic resonance imaging, ultrasound, and optical imaging. In addition, as a basis for biomedical imaging, introductory material on general image formation concepts and characteristics are presented, including human visual perception and psychophysics. Undergraduate equivalents: BIEG 4332, CPEG 4332.

ECEG 5333 Biomedical Visualization **3 Credits**
An introduction to 3D biomedical visualization. Various technologies are introduced, include ultrasound, MRI, CAT scans, PET scans, etc. Students will learn about spatial data structures, computational geometry and solid modeling with applications in 3D molecular and anatomical modeling. Undergraduate equivalents: BIEG 4333, CPEG 4333.

ECEG 5334 Unmanned Aerial Vehicles: Design, Navigation, and Control **3 Credits**
Prerequisite: ELEG 2213, CPSC 1131 or ENGR 2145 or Equivalent.
This course provides an in-depth exploration of unmanned aerial vehicles (UAVs), focusing on their design, navigation, and control. Students will learn the fundamental principles of UAVs, how to design and build basic drones, and apply advanced control and sensor fusion techniques for effective navigation and stabilization. The course also covers the use of UAVs in various applications like photogrammetry and payload delivery, along with a thorough understanding of the regulatory and ethical issues surrounding drone operations. Undergraduate equivalent: ENGR 4334.

ECEG 5335 Microelectronics **3 Credits**
This course considers the methods of interconnecting electronic components at very high circuit densities and describes methods of designing and fabricating multilayer printed circuit boards, co-fired multilayer ceramic substrates, and multilayer thin film substrates in detail. It discusses the methods of depositing thick and thin film materials, along with their properties, and analyzes these structures and compares them for thermal management, high frequency capability, characteristic impedance, cross-coupling of signals, and cost. The course also includes techniques for mounting components to these boards, including wire bonding, flip chip, and tape automated bonding. Undergraduate equivalent: ELEG 4335.

ECEG 5336 Analog Electronics Design **3 Credits**
Prerequisite: ELEG 3231, ELEG 3231L or equivalent or permission from instructor.
This advanced course in electronics examines high frequency response of bipolar junction transistor and field-effect transistor amplifiers using hybrid two-port active device models. Students consider the effect of feedback and frequency compensation techniques on the amplifier response and study a variety of analog circuits with respect to their analysis and applications, including active filters, oscillators, waveform generation and shaping, voltage regulator, and communication circuits. The course introduces basic power electronics device components. Undergraduate equivalent: ELEG 4331.

ECEG 5346 Computer Systems Architecture **3 Credits**
An investigation into computer architectures (past, present and future). We will explore various hardware and software techniques designed to maximize parallelism and improve performance. Front-end design (branch prediction, instruction fetch, trace caches), HW/SW techniques of parallelism, Memory system design (caching, prefetching), Technology issues (low power, scaling, reliability, nanotechnology), multiprocessors. Class will include a mix of lectures and discussions on assigned readings of recent publications. Students will be responsible for leading and participating in these discussions. A course project exploring a particular topic in depth will be required. Undergraduate equivalent: CPEG 3346.

ECEG 5348 Embedded Microcontrollers **3 Credits**
Corequisite: ECEG 5348L.
Introduction to embedded microcontrollers in electronic and electromechanical systems. Hardware and software design techniques are explored for user and system interfaces, data acquisition and control. These tools are used to develop software code for practical applications such as motor speed control and voltage regulation for power supplies. Undergraduate equivalent: ELEG 3348.

ECEG 5348L Embedded Microcontrollers Lab **1 Credit**
Fee: $120 Engineering Lab Fee
This laboratory covers the basic operation and applications of a microprocessor. Students learn to program a microprocessor to control applications such as motor speed by the use of an emulator connected to a PC. They design a circuit using a microprocessor for a specific application and write a program to control the circuit. On completion of the program, they use the emulator to program an actual microprocessor for use in their circuit. Undergraduate equivalent: ELEG 3348L.

ECEG 5355 Sensor Design and Application **3 Credits**
This course covers the design, fabrication, and properties of sensors intended to measure a variety of parameters, such as stress, temperature, differential pressure, and acceleration. Sensors of different types are used in a wide range of equipment, especially automated equipment, to detect changes in state and to provide the signals necessary to control various functions. Sensors are generally connected to electronics systems that process and distribute the signals. The support electronics must identify the signal, separate it from noise and other interference, and direct it to the appropriate point. These support electronics are a critical part of the sensor technology; students discuss their design and packaging in detail. Undergraduate equivalent: ELEG 4355.

ECEG 5361 Green Power Generation **3 Credits**
This course compares various methods of green power generation including solar power, wind power, water power, and several others. This course covers how power is generated from these sources, the startup costs, the efficiency, and the practicality. These methods are compared to the present most common method of using oil and gas to heat water into steam to turn turbines. The student does not necessarily need a background in engineering and any necessary background material will be covered to the understanding of all. Undergraduate equivalent: ELEG 4361.

ECEG 5365 Internet of Things **3 Credits**
Prerequisite: ELEG 3348, ELEG 3348L or equivalent.
This course introduces one or more of the possible hardware devices that support Internet of Things (IoT). The associated communication protocols, storage of data, and the distributed systems needed to support IoT applications will be discussed. Practical IoT device programming (Arduino and Raspberry Pi, STM 32, Azure Sphere devices), and technologies for sensing and collecting data, and utilizing them to design actuating mechanism or data analysis will be presented. Selected IoT protocol stacks (Zigbee, Bluetooth, WiFi) for networking and security enforcement will be presented. Cloud-based IoT platforms such as AWS, Azure will be discussed. Student class project will include development of an IoT application with practical sensor data collection and deployment on a cloud-based IoT service platform. Undergraduate Equivalent: ELEG 4365.

ECEG 5375 Bioelectronics **3 Credits**
Bioelectronics have emerged as an exciting research area due to the integration of molecular biology with electronics to create fundamental devices. This course is intended for senior and graduate level engineering students. It will introduce fundamentals of bioelectronics through chemical, biochemical and biophysical concepts from the engineering perspective. It will further apply these concepts to the areas of electron transport through biological macromolecules, microfluidics, electrochemical techniques, DNA and neuron-based electronics, biomaterials and semiconductor-based bioelectronics.

ECEG 5377 Power Security and Reliability **3 Credits**
Prerequisite: ECEG 5385.
This course focuses on Power System Protection and Relaying to allow the design of robust and reliable power systems. After reviewing the need for protection of power system elements (motors, generators, transformers, and transmission/distribution lines), the course: Explores developments in the creation of smarter, more flexible protective systems based on advances in the computational power of digital devices and the capabilities of communication systems that can be applied within the power grid, Examines the regulations related to power system protection and how they impact the way protective relaying systems are designed, applied, set, and monitored, Considers the evaluation of protective systems during system disturbances and describes the tools available for analysis, Addresses the benefits and problems associated with applying microprocessor-based devices in protection schemes' Contains an expanded discussion of internal protection requirements at dispersed generation facilities. MatLab is used to solve homework problems and do team design projects. Undergraduate equivalent: ELEG 4377.

ECEG 5378 Electromagnetic Compatibility **3 Credits**
This course presents design techniques to minimize electromagnetic interference (EMI) from an electronic system or to it. The various sources of Radio-frequency emissions from electronic systems, coupling paths for the transfer of undesired electromagnetic energy will be introduced. Electromagnetic Compatibility (EMC) requirements for electronic products will be presented along with techniques to measure EMI. High speed digital signal transmission integrity related issues and methods to overcome signal integrity will be introduced. Techniques to minimize conducted and radiated Emissions through filtering and grounding will be presented. System design for EMC will be presented. Undergraduate equivalent: ELEG 4378.

ECEG 5379 Communication Systems **3 Credits**
This course focuses on analog and digital communication systems and the effects of noise on those systems. It includes analog modulation and demodulation techniques (amplitude, frequency, and phase modulation) and digital modulation and demodulation techniques (ASK, FSK, PSK, PCM, and delta modulation). It discusses performance analysis of analog and digital communication systems under noise with applications of probability theory to the analysis. It discusses information measure, source coding, error correcting codes and Spread spectrum systems. Undergraduate equivalent: ELEG 4379.

ECEG 5385 Power Generation and Distribution **3 Credits**
This course considers the generation and distribution of electrical power to large areas. Three-phase networks are described in detail, including both generators and loads. Methods of modeling distribution systems by per-unit parameters are covered, along with power factor correction methods. Fault detection and lightning protection methods are also described. Some economic aspects of power generation and distribution are presented. Undergraduate equivalent: ELEG 4385.

ECEG 5386 Fault Analysis in Power Systems **3 Credits**
Prerequisite: ECEG 5385.
This course covers three types of faults in electrical power grids: open lines, lines shorted to ground, and lines shorted to each other. Methods of locating faults are covered, along with an analysis of the effects. Methods of protection and fault isolation are also covered. Undergraduate equivalent: ELEG 4386.

ECEG 5387 Instrumental Analysis in Biomedical Engineering **3 Credits**
This course will give an overview on several important analytical tools for characterizing the nanomaterials that are functionally engineered towards biomedical applications. Quantification of mechanical, electrical, electronic and biological properties of the nanomaterials such as carbon nanotubes, metal nanoparticles, quantum dots, nanowires, polymeric nanoparticles and biomedical nanomaterials will be discussed. Fundamental principles of the associated instruments and the evaluation of the physical, chemical and microscopy methods for materials in nano-regime will be highlighted. Modern material science depends on the use of a set of analytical methods that are used normally in specialized laboratories. This course will help the students get familiar with the basics of such specialized methods, their range of applicability and reliability, especially when the materials under test are in sub-100nm dimensions.

ECEG 5405 Electronic Materials **3 Credits**
This course describes the properties and applications of certain materials used in the design and manufacture of electronic assemblies. Ceramics are often used as insulators, heat sinks, and substrates for interconnection structures. The course presents electrical, mechanical, and thermal properties of various ceramics, along with methods of fabricating and machining ceramic structures. Adhesives used to mount components and to replace mechanical fasteners such as screws and rivets provide connections that are stronger and take up less space. The course examines properties of adhesives such as epoxies, silicones, and cyanoacrylates under conditions of high temperature storage and humidity, along with methods of applications. Solders used to interconnect electronic components and assemblies are selected for temperature compatibility, mechanical properties, and reliability. The course emphasizes the new lead-free solder materials and presents the properties of plastic materials and the methods of forming plastic structures.

ECEG 5406 Advanced Digital Design **3 Credits**
This course examines computer architecture implemented using a hardware design language and programmable logic devices. Students learn the VHDL hardware description language, and learn to use modern design, simulation, and synthesis software. Students design, verify, build and test digital logic circuits using industry standard development boards, and field programmable gate array (FPGA) technology.

ECEG 5407 Computational Genomics **3 Credits**
This course will provide an overview of computational genomics. Students will obtain skill in analyzing genomic data and sequencing experiments. The focus will be on achieving proficiency in data management and processing based on popular file formats in genomic biology.

ECEG 5411 Digital Signal Processing **3 Credits**
Modern signal processing tools including vector spaces, bases and frames, operators, signal expansions and approximation, as well as classical signal processing tools including Fourier and z transforms, filtering and sampling, estimation, applications, and implementation.

ECEG 5415 Engineering Applications of Numerical Methods **3 Credits**
This course provides students with the theoretical basis to proceed in future studies. Topics include root-finding, interpolation, linear algebraic systems, numerical integration, numerical solution of ordinary and partial differential equations, modeling, simulation, initial boundary value problems, and two point boundary value problems. Undergraduate equivalent: ENGR 4415. Crosslisted with MEEG 5415.

ECEG 5420 Readings in Electrical and Computer Engineering **3 Credits**
Students formulate a project proposal, perform literature surveys, and learn the finer points of technical writing and presentation at the graduate level. The course requires a meta-paper written about the literature in the field. It emphasizes the basics of technical writing and research, and is organized to emphasize methods of the writing and the research process. Students learn to state a problem, the techniques of analysis, methods of investigation, and functional organization.

ECEG 5457 Advanced Linear Systems **3 Credits**
Modeling and analysis of linear systems. Introduction to linear algebra with emphasis on matrices, linear transformations on a vector space, and matrix formulation of linear differential and difference equations. State variable analysis of advanced linear systems. Transform methods using complex variable theory, and time-domain methods including numerical algorithms.

ECEG 5460 Network Programming **3 Credits**
This course covers principles of networking and network programming. Topics include OSI layers, elementary queuing theory, protocol analysis, multi-threading, command-line interpreters, and monitors. Students write a distributed computing system and check their performance predictions with experiments.

ECEG 5470 Network Embedded Systems **3 Credits**
This course covers distributed development: connecting peripherals to networks via Java. Plug-and-play paradigm is used to add services on the fly. Students learn about the following topics: multicast and unicast protocols, service leasing, lookup services, remote events, sharing data between distributed processes, and distributed transactions. The course also covers interfacing hardware (sensors, robotics, etc.) to the Web.

ECEG 5480 Wireless Systems I **3 Credits**
The applications of wireless communication are expanding rapidly - from cellular phones to wireless internet to household appliances - and involve many disciplines other than microwave transmission. This course covers several aspects of wireless communication, including antenna design, FCC regulations, and multi-channel transmission protocols. In addition, it discusses modern design approaches such as Bluetooth. Students learn how analog and digital signals are coded. The course also discusses transmission during interference and EMI/RFI as well as fiber optics communication.

ECEG 5505 Advanced Power Electronics **3 Credits**
This course considers the design and application of electronic circuits related to power generation and conversion including inverters, power supplies, and motor controls. Topics include AC-DC, DC-DC, DC-AC, AC-AC converters, resonant converters, and the design of magnetic components. Models of electric motors and generators are presented to facilitate the design of controls for these structures.

ECEG 5508 Engineering Entrepreneurship **3 Credits**
Designed specifically for engineers and scientists having a passion for technological innovation, this popular interdisciplinary course focuses on the roles of inventors and founders in successful high-tech ventures. By providing knowledge and skills important to the creation and leadership of such startups, the course aims to train the founders and leaders of tomorrow's high-tech companies. This course makes use of case-studies and active learning to engage the students in venture creation. Guest lectures enable industry experts to share their insights for venture formation.

ECEG 5510L Product Design Lab **1 Credit**
Fee: $120 Engineering Lab Fee
Prerequisite: ECEG 5405.
This laboratory course provides hands-on experience in measuring and analyzing the electrical and mechanical properties of materials used in the design of electronic products. It also covers thermal analysis and methods of removing the heat from electronic circuits. Experiential learning includes measurement of temperature coefficient of expansion, measurement of thermal resistance, measurement of tensile strength, measurement of material hardness, temperature measurement of electronic components, Peltier effect (thermoelectric coolers), heat pipes, convection cooling (fins and air flow), and heat flow across a bonding interface such as solder or epoxy.

ECEG 5520L System Design Lab **1 Credit**
Fee: $120 Engineering Lab Fee
Corequisite: ECEG 5355.
This laboratory provides students with an understanding of sensors and non-linear control systems. Experiments include temperature sensors such as thermocouples, thermistors, and infrared, motion sensors, strain gauges, non-linear servos, and computer analysis of nonlinear systems.

ECEG 5990 Independent Study **1-3 Credits**
Graduate students pursue special topics, projects, and/or readings in selected areas. Students must meet with the instructor to discuss the proposed topic of study. Enrollment by departmental approval only

ECEG 6971 Thesis I **3 Credits**
Prerequisite: ECEG 5420.
The master's thesis tests students' abilities to formulate a problem, solve it, and communicate the results. The thesis is supervised on an individual basis. A thesis involves the ability to gather information, examine it critically, think creatively, organize effectively, and write convincingly; it is a project that permits students to demonstrate skills that are basic to academic and industry work. The student must also submit a paper for possible inclusion in a refereed journal appropriate to the topic.

ECEG 6972 Thesis II **3 Credits**
Prerequisite: ECEG 6971.
The master's thesis tests students' abilities to formulate a problem, solve it, and communicate the results. The thesis is supervised on an individual basis. A thesis involves the ability to gather information, examine it critically, think creatively, organize effectively, and write convincingly; it is a project that permits students to demonstrate skills that are basic to academic and industry work. The student must also submit a paper for possible inclusion in a refereed journal appropriate to the topic.