Department of Electrical Engineering and Computer Science

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The Department of Electrical Engineering and Computer Science spans the technologies at the forefront of our economy and our society. Professionals in these fields are responsible for developing microprocessors and personal computers, and the operating systems, computer software, and Internet applications which run on them. Almost every modern device contains an integral computer chip. New developments in such areas as medical electronics, automotive safety and control, automated manufacturing, and entertainment electronics continue to provide opportunities for our graduates.

The Department of Electrical Engineering and Computer Science (EECS) is structured into four programs: electrical engineering, computer engineering, systems and control engineering, and computer science. Each area offers a degree program which leads to the Bachelor of Science degree. All engineering programs in the department are accredited by the Accreditation Board for Engineering and Technology (ABET). The department also offers a Bachelor of Arts in computer science for those students who wish to combine a technical degree with a broad education in the liberal arts. At the graduate level the department offers the Master of Science and Doctor of Philosophy degrees in electrical engineering, computer engineering, systems & control engineering, and computing and information sciences.

History

The Electrical Engineering component of the department taught its first electrical engineering class in 1886 making it one of the oldest in the nation. The department has always been innovative and first in many things. The Systems & Control Engineering program was the first of its kind to be accredited by ABET and grew out of the Systems Research Center, originally founded in 1959. The computer engineering program was the nation’s first ABET accredited computer engineering program.

Education

The EECS department is dedicated to producing high-quality graduates who will take positions of leadership. We recognize that the increasing role of technology in virtually every facet of our culture— communications, transportation, health care, the environment, and even our system of wealth distribution — makes it vital that engineering-oriented students have access to progressive and cutting-edge programs stressing excellence in:

- mastery of fundamentals
- creativity
- social awareness
- leadership skills and
- professionalism.

Emphasizing these core values will help ensure that tomorrow’s graduates are valued and contributing members of our global society and that they will carry on the tradition of engineering leadership established by our alumni.

Statement of Educational Philosophy

Our goal is to graduate students who have fundamental technical knowledge of their profession and the requisite technical breadth and communications skills to become leaders in creating the new techniques and technologies which will advance their fields.

To achieve this goal, the department offers a wide range of technical specialties consistent with the breadth of electrical engineering & computer science, including recent developments in the field. Because of the rapid pace of change in these fields our degree programs emphasize a broad technical background that equips students for future developments. As a result, our programs include a wide range of electives and our students are encouraged to develop individualized programs which can combine many aspects of electrical engineering and computer science. The department prepares students for careers in engineering with degrees in electrical engineering, computer engineering, computer science or systems & control engineering.

The department programs emphasize a mastery of fundamentals which will enable students to deal with new technological developments and interact with professionals in other fields. This is achieved by ensuring that our graduates have:

- a strong background in the fundamentals of chemistry, physics, mathematics, and computing
- an ability to design and construct engineering models by applying fundamental knowledge of mathematics, science, and engineering
- an ability to analyze engineering models utilizing state of the art engineering techniques, skills, and tools
- an ability to design and construct experiments to collect data, and to analyze and interpret the resulting data to develop and verify engineering models
- a broad education necessary to understand the impact of electrical engineering solutions in a modern society.

Technological development continues to result in new technologies and/or new problems. We ensure that our graduates are creative and able to apply their engineering knowledge to new problems by

- training them in the modeling, behavior, and specification of engineering components, systems, and/or processes
- training them in the planning, design, implementation, and operation of systems, components, and/or processes that meet engineering constraints
- providing significant design experience which involves problem definition, research, solution formulation, economics, communications, teamwork, and project management

We live in a complex technological society which requires that our graduates have a broad education necessary to understand the consequences of engineering solutions in the broader context of their impact upon people and the environment. We ensure that our graduates are socially aware by

- requiring that they have an extensive education in the humanities and social sciences
- by providing opportunities for and encouraging them to pursue additional studies in the humanities, social sciences and business.

We expect our students to become leaders in creating and applying new technologies by

- developing their written and oral communication skills, including the use of modern electronic tools such as presentation software, the World Wide Web, and e-mail
- providing group activities which develop teamwork and communications skills
- teaching them how to find technical information and research engineering problems, especially using electronic resources
- going outside the boundaries of individual textbooks as a preparation for life-long learning
- providing opportunities for students to develop and demonstrate leadership in professional organizations, engineering and research

We develop our students as professionals by developing their communications and leadership skills and additionally by

- training them to understand professional and ethical responsibility
- committing them to the highest standards of such responsibility and excellence in all their professional endeavors

- providing them with opportunities for professional development through the Co-Operative Education Program

Faculty

B. Ross Barmish, Ph.D. (Cornell University)
  Department Chair, Nord Professor
  Control systems, robustness, probabilistic methods, Monte Carlo simulation
Randall D. Beer, Ph.D. (Case Western Reserve University)
  Professor
  Computational neuroscience, autonomous robotics
Michael S. Branicky, Sc.D. (Massachusetts Institute of Technology)
  Associate Professor
  Intelligent systems and control, hybrid systems, learning, real-time and distributed control over networks, applications to robotics and flexible manufacturing
Marc Buchner, Ph.D. (Michigan State University)
  Associate Professor
  Computer simulation of complex systems, control of industrial systems, analysis of discrete event and combined systems
Vira Chankong, Ph.D. (Case Western Reserve University)
  Associate Professor
  Large-scale and multi-objective optimization and its application to engineering problems, manufacturing and production systems, improvement of magnetic resonance imaging, decision theory, and risk analysis
Funda Ergun, Ph.D. (Cornell University)
  Schroeder Assistant Professor
  Program testing routing and quality of service in high speed networks, packet classification, randomized algorithms, learning theory
George W. Ernst, Ph.D. (Carnegie Institute of Technology)
  Associate Professor
  Learning problem solving strategies, artificial intelligence, expert systems, program verification
Steven L. Garverick, Ph.D. (Massachusetts Institute of Technology)
  Associate Professor
  Mixed-signal integrated circuit design, microelectromechanical system integration, sensor/actuator interfacing, data conversion, wireless communication, analog neural network circuits, medical instrumentation
Dov Hazony, Ph.D. (University of California, Los Angeles)
  Professor
  Network syntheses, ultrasonics, communications
Vincenzo Liberatore, Ph.D. (Rutgers)
  Assistant Professor
  Distributed Systems, internet computing, randomized algorithms
Wei Lin, Ph.D. (Washington University)
  Associate Professor
  Nonlinear dynamic systems and geometric control theory, H-infinity and mixed H-2/H-infinity and robust control, adaptive control, system parameter estimation, adaptive and nonlinear control for robotics manipulators
Kenneth Loparo, Ph.D. (Case Western Reserve University)
  Professor
  Stability and control of nonlinear and stochastic systems, analysis and control of discrete event systems, intelligent control systems and failure detection. Recent applications work focuses on the control and failure detection of rotating machines.
Behnam Malakooti, Ph.D. (Purdue University)
  Professor
  Industrial engineering, computer-aided manufacturing, man-machine systems, AI, Multiple criteria decision making and optimization
Mehran Mehregany, Ph.D. (Massachusetts Institute of Technology)
  Silicon and silicon carbide microelectromechanical systems (MEMS), micromachining and microfabrication and related integrated circuits, materials, and modeling issues
Frank Merat, Ph.D. (Case Western Reserve University), PE (Ohio)
  Associate Professor and Associate Chair for Undergraduate Studies
  Wireless networks, RF communications, optical MEMS devices, computer vision and image processing, neural networks
Mihajlo D. Mesarovic, Ph.D. (Serbian Academy of Science)
  Cady Staley (Hanna) Professor
  Complex systems theory, global issues and sustainable development
Wyatt Newman, Ph.D. (Massachusetts Institute of Technology)

Professor
Mechatronics, high -speed robot design, force and vision-based machine control, artificial reflexes for autonomous machines, rapid prototyping, agile manufacturing

Gultekin Ozsoyoglu, Ph.D. (University of Alberta, Canada)
Professor
Databases, multimedia computing, digital libraries

Z. Meral Ozsoyoglu, Ph.D. (University of Alberta, Canada)
Professor
Database theory, logic databases, database query and optimization

C.A. Papachristou, Ph.D. (Johns Hopkins University)
Professor
VLSI design and CAD, computer architecture and parallel processing, design automation, embedded system design

Stephen M. Phillips, Ph.D. (Stanford University), PE (Ohio)
Associate Professor
Applications of control and signal processing to robotics and automation

Andy Podgurski, Ph.D. (University of Massachusetts at Amherst)
Associate Professor
Software engineering methodology and tools, software architecture and design, distributed systems, software testing and reliability estimation

Daniel Saab, Ph.D. (University of Illinois at Urbana-Champaign)
Associate Professor
Computer architecture, VLSI system design and test, CAD design automation

S. Cenk Sahinalp, Ph.D. (University of Maryland)
Assistant Professor
Design, analysis and experimental evaluation of algorithms for pattern matching and indexing; data compression, communication networks and computational molecular biology

N. Sreenath, Ph.D. (University of Maryland)
Associate Professor
Large-scale systems, policy analysis, sustainable development, integrated assessment, global and environmental issues (water resources and global climate change), control theory applications and medical informatics

Massood Tabib-Azar, Ph.D. (Rensselaer Polytechnic Institute)
Professor
Semiconductor material and device characterizations, optical signal processing, novel high-frequency and high-power devices and circuits, spectroscopy and low temperature measurement, novel super-resolution near-field imaging probes, quantum computing

Lee J. White, Ph.D. (University of Michigan)
Professor and Associate Chair for Graduate Studies
Software testing, current projects include regression testing, study of domain testing, specification-based testing and testing of object-oriented software

Darrin Young, Ph.D. (University of California, Berkeley)
Assistant Professor
Micromachined sensors, high-Q passive components and integrated low power analog circuits for wireless communications

GQ (Guo-Qiang) Zhang, Ph.D. (Cambridge University, England)
Associate Professor
Programming languages, theory of computation, logic and topology in computer science

Associated Faculty

Secondary Faculty

Coleman B. Brosilow, Ph.D. (Brooklyn Polytechnic Institute)
Professor, Chemical Engineering

Robert V. Edwards, Ph.D. (Johns Hopkins University)
Professor, Chemical Engineering

Joseph Koonce, Ph.D. (University of Wisconsin, Madison)
Professor, Biology Department

Adjunct Faculty

Joan Carletta, Ph.D. (Case Western Reserve University)
Adjunct Assistant Professor

Howard Chizeck, Sc.D. (Massachusetts Institute of Technology)
Adjunct Professor

Benjamin F. Hobbs, Ph.D. (Cornell University)
Adjunct Professor

Pat Howard, Ph.D. (Case Western Reserve University)
Adjunct Assistant Professor

Peter Kinman, Ph.D. (University of Southern California)
Adjunct Assistant Professor
Geoffrey Lockwood, Ph.D. (University of Toronto, Canada)
Adjunct Assistant Professor (Cleveland Clinic)
Marvin Schwartz, Ph.D. (Case Western Reserve University)
Adjunct Assistant Professor
Peter Tsivitse
Adjunct Professor
Clayton Van Dorn, Ph.D. (Syracruse University)
Adjunct Assistant Professor
Chris Zorman, Ph.D. (Case Western Reserve University)
Adjunct Assistant Professor

Emeritus Faculty

Paul C. Claspy, Ph.D. (Case Institute of Technology)
Emeritus Associate Professor
Communications, and imaging, lasers and electro-optics
Robert E. Collin, Ph.D. (Imperial College, University of London, England)
Emeritus Professor
Electromagnetic theory, antennas, propagation, microwave components and systems
Sheldon Gruber, Sc.D. (Massachusetts Institute of Technology)
Emeritus Professor
Signal processing, machine vision and industrial inspection
Wen H. Ko, Ph.D. (Case Institute of Technology)
Emeritus Professor
Solid state sensors and devices, biomedical implants, telemetry
Irv Lefkowitz, Ph.D. (Case Institute of Technology)
Emeritus Professor
Automation and computer control of industrial processes
Osman K. Mawardi, Ph.D. (Harvard University)
Emeritus Professor
Plasma Physics, energy conversation and storage, applied superconductivity
Harry W. Mergler, Ph.D. (Case Institute of Technology)
Leonard Case Emeritus Professor
Digital systems, systems engineering, logical design computer control, metrology
Yoh-Han Pao, Ph.D. (Pennsylvania State University)
George S. Dively Emeritus Professor
Pattern recognition, signal and image processing, computational intelligence, intelligent systems
Frederick J. Way III
Emeritus Professor

Research Activities

EECS programs at Case Western Reserve encompass a wide spectrum of activities. Some of the major activities include biorobotics and computational intelligence, automation and robotics, solid-state devices and MEMS, communications, nanoelectronics and nanometrology techniques, global and large-system modeling, software engineering,and databases and bioinformatics. Much of this research is multi-disciplinary in nature involving faculty members from Materials Science and Engineering, Biology, Psychology, Civil Engineering, and Mechanical and Aerospace Engineering.

The faculty of the department actively pursue research in the areas described below. Students pursue their thesis research under the supervision of a faculty member who is a recognized authority in his field. Support for thesis research comes from a related research project or program under the direction of the faculty. For further information on research opportunities, the department chair should be contacted.

Algorithms - Professors Ergun, Liberatore and Sahinalp

Basic theoretical and applied work in randomized algorithms, program testing and correcting, learning theory, learning theory, multivariate optimization, data structures, string and sequence algorithms, combinatorial and statistical pattern matching and indexing, embedding of metric spaces, data compression and complexity of communication, algorithmic analysis of massive data sets, sketching and streaming models, parallel computation and circuit layouts, experimental algorithmics and performance evaluations.

Automation, Sensing, Actuation and Machine Intelligence - Professors Barmish, Branicky, Liberatore, Loparo, Malakooti, Merat, Newman, Pao and Phillips

Research activities include neural network applications; pattern recognition; artificial intelligence; hybrid systems, process automation; intelligent machine tool control; in-process gauging and control; adaptive learning methods applicable to robotics; system identification and adaptive control; intelligent control; the application of artificial intelligence to robotics systems and manufacturing; compliant control of robotics systems; non-contact inspection of production quality; machine vision for robotics applications; agile manufacturing systems; machine vision and image processing; rapid prototyping of computer-generated 3-D objects in engineering materials; computational intelligence, principles and applications; distributed computational intelligence in network client/server mode; computational intelligence and associative memories; robustness considerations and related statistical techniques.

Circuits and Computer-Aided Design - Professors Garverick, Young and Merat

Research activities include SiC circuits, and mixed-signal CMOS integrated circuit design for applications in MEMS, biomedical instrumentation, and robotics, MEMS RF high-Q tuning components for mobile communication circuits, MEMS sensors for biomedical and inertial sensing applications, microfabrication and integrated circuits process development.

Computer Networks - Professors Ergun, Liberatore, Malakooti and Sahinalp

Research activities include data dissemination, background distributed computing, distributed middleware and services, overlay networks, quality of service, routing, random graphs for network modeling, and packet filtering and classification; development of intelligent networks using intelligent mobile agents.

Computational Genomics - Professors Sahinalp, M. Ozsoyoglu, Pao and Buchner

Current research activities include: (1) computational studies of large scale genome duplication and other genome-wide rearrangements; (2) phylogenetics of the human genome, (3) algorithmic tools for pattern/motif search and discovery.

Computational Neuroscience and Autonomous Robotics - Professor Beer

Using computer simulation and theoretical analyses of models of complete neural/body/environment systems, this research pursues two objectives. First, it seeks to better understand the neural mechanisms of behavior in animals. Second, it seeks to apply biological control principles to the design of autonomous robots with the flexibility ad robustness of animals. The tools employed in this work include continuous-time recurrent neural networks, evolutionary algorithms, and dynamical systems theory. This research is highly interdisciplinary, and includes collaborators from the Department of Biology and the Department of Mechanical and Aerospace Engineering.

Control Applications - Professors Barmish, Branicky, Buchner, Loparo, Liberatore, Lin and Phillips

Topics include: (1) The development of anti-lock braking systems using fuzzy logic control methods; (2) Development of methods of automotive control and computer assisted tools for engineering analysis and design (e.g., development of computer based tools for system level failure mode effect analysis); (3) Developing technology for advanced power train, energy management, sensing and control strategies for electric vehicles; (4) the use of methods of control engineering to solve problems involving industrial and manufacturing processes; (5) developing advanced analysis and design tools for robotic assembly, agile manufacturing, (6) control over networks (QoS provisioning and multi-agent software).

Control, Filtering and Robustness - Professors Barmish, Lin and Loparo

Topics include: (1) nonlinear control theory work addressing questions regarding the behavior, stability and control of dynamic systems that are inherently nonlinear in the relationships between their inputs, outputs, and internal states; (2) stochastic control theory work involving the study of the behavior, stability and control of dynamic systems that possess an element of randomness in their operation over time; (3) stochastic filtering theory work, investigating the extraction of information about internal variables of a system on the basis of (possibly noise corrupted) measurements of system outputs; and (4) Robust control and analysis with emphasis on new Monte Carlo techniques and models for addressing system uncertainty.

Database Systems - Professors M. Ozsoyoglu and G. Ozsoyoglu

This research area focuses on performance issues in relational databases, database query processing and distributed database query processing, file allocation in distributed databases, database design, object-oriented databases, statistical database security problems, and relational interfaces for non-relational databases.

Design Methodologies and Design Automation - Professors Saab and Papachristou

This research area is concerned with the development of behavioral and structural level design methodologies and tools for the creation of VLSI-based systems and for multiple-processor architectures. Central to this work is the continued development of a third-generation design automation system for VLSI.

Electromagnetics, High Frequency Communications and Devices - Professors Hazony, Ko, Merat, Tabib-Azar and Young

Research activities include electromagnetic propagation and scattering, high frequency acoustic circuits, generation and detection of extremely sharp pulses, in situ monitoring in aggressive environments, biotelemetry, wireless communications for in situ arrays of biosensors.

Expert Systems - Professors Ernst, Malakooti, Merat, Paoand and Zhang

The research on expert systems is primarily concerned with using artificial intelligence techniques to represent and reason about knowledge. Current research includes (1) common-sense reasoning; (2) development of multiple criteria based expert systems for solving design and facility layout problems; and (3) applied research in a number of different challenging applications, such as fault diagnosis in discrete event systems. Most of these applications are based on knowledge which has been extracted from experts in the application domains.

Fault Detection and Diagnosis - Professors Loparo and Lin

Research combining advanced theoretical topics with solutions to industrial problems of high relevance and economic importance. Topics include: (1) the detection specific identification of failure events in systems and, when possible, the detection of incipient failures, through the use of nonlinear filtering of measured system inputs and outputs; and (2) the use of nonlinear dynamics and chaos theory for failure detection, the use of chaos concepts and other advanced model-based methods for vibration signature analysis.

Global Systems Analysis and Sustainable Development - Professor Mesarovic and Sreenath

This research addresses one of the most challenging tasks of systems science and systems engineering, i.e., to understand the world as a system and develop methods to assess the evolution of the system. In order to advance understanding of the global system, two principle obstacles are being addressed: complexity by using a multi-level, hierarchical architecture and uncertainty by interactive human/computer reasoning support process. The focus of the research is on interaction between global issues which represents a distinguishing characteristic of the global future (referred to as the global problematique). A range of issues are considered-from demographic transition and aging to carrying capacity, prospects for global climate change, impact of financial markets on development, etc. Collaborative research with a global network of universities is underway through the UNESCO Global-problematique Education Network Initiative (Genie). The Network is made up of fifteen universities from countries around the world strategically selected in order to provide a global coverage. Joint research with member institutions is conducted via the Internet. The research ranges from modeling and methods of complex systems analysis under true uncertainty analysis of specific issues such as global coordination of greenhouse gas emission reduction policies, water resources and health carrying capacity of Africa, etc.

Identification and Adaptive Control - Professors Lin and Buchner

Research directed towards specific application problems and the development of new theory. Topics include: (1) adaptive control of nonlinear systems, adaptive control of multi-input, multi-output systems having unknown and time varying input-output delays; (2) predictive adaptive control of non-minimum phase systems and the development computationally efficient methods of predictive control; (3) development and application of methods for real-time identification of parameters for linear systems having unknown input-output delays, and for nonlinear systems.

Industrial, Production, Operational, Management Systems - Professors Malakooti and Chankong

Optimization, multiple criteria decision making, and artificial intelligence techniques are used to improve quality, productivity, and cost efficiency of real-world problems including development of computer aided and integrated manufacturing/production planning and control; facility layout design, assembly line balancing; pattern recognition and clustering applied to group technology family formation; scheduling, machine set-up, tool life, and machinability. Research activities include applying optimization, decision making, multiple objectives (criteria), AI, artificial neural networks, pattern recognition/clustering to facility layout design, group technology, and assembly systems as well as developing multiple objective optimization and analysis for machine set-up, supervision, tool life, machinability, and sensing devices.

Intelligent Systems, Neural Nets And Fuzzy Logic - Professors Loparo, Pao, Branicky, Merat, Malakooti and Tabib-Azar

The use of methods of “machine intelligence” to accomplish control of systems. Particular topics of interest include: (1) the use of feed forward artificial neural nets to detect tool wear in parts machining processes, and to model load demand of electric power systems; (2) the use of fuzzy logic methods to attain anti-lock braking for automobiles, to control manufacturing processes and chemical processes, to detect events of gait in neuro-prosthetic systems that provide walking for paraplegics using electrical stimulation; (3) the analysis of combined discrete and continuous state ‘hybrid’ dynamic systems; and (4) novel computation techniques such as quantum computing and associated networks.

Logic, programming, and verification -
Professor Zhang

Research activities include the semantics of programming languages and logic and models for reasoning about software, hardware, and security-critical systems.

Mathematical Modeling and Systems Analysis of Global Change Phenomena - Professors Mesarovic and Sreenath

The use of mathematical modeling of global economic and physical phenomena, in conjunction with computer simulation, to develop alternative scenarios of the future. This work involves a determination of what changes are possible within an environmental system, on the basis of the structure of mathematical models that represent its behavior (or hypotheses about its behavior).

Optimization and Decision Theory and Methods - Professors Malakooti and Chankong

Basic theoretical work and specific applications. Topics include: (1) Multi-objective optimization theory; (2) Algorithms for machine part formation problems; (3) Clustering algorithms for data compression; (4) Algorithms and tools for VLSI design; (5) Algorithms and methods for facility location and layout in manufacturing systems; (6) the use of systems analysis and decision theory methods to solve problems of the electric utility industry, such as quantification of the implications of transmission constraints for generation costs and resource planning.; (7) methods for the design of magnetic resonance imaging (MRI) pulse sequences, for clinical MR images. to allow for the removal of motion artifacts (e.g., in images of the liver) and enhancements of images specific tissue types; and (8) the application of systems analysis and decision theory methods to problems of information flow and control in health care.

Semiconductor Materials and Devices - Professors Tabib-Azar, Mehregany, Young, Garverick and Ko

Research activities include design, modeling, fabrication, testing, and application of a wide range of micro-to-nano systems, with particular emphasis on supporting materials technology, including silicon carbide. Example devices include micromachined components, sensors; actuators; opto-mechanical devices including scanners and switches; electronic devices; microwave probes; electromagnetic devices and filters, and wireless communication components and subsystems. Example applications are in fields such as transportation, telecommunications, space, biomedical, and industrial control.

Signal processing - Professors Buchner, Loparo, Merat and Pao

Research activities include neural network signal and information processing, image processing, time-frequency signal analysis, processing of genomic information, detection of tornados in radar images using wavelets, two-dimensional periodicity transforms.

Software Architecture and Design - Professors Podgurski , White and Zhang

The objective of this research is to develop, specify, and analyze prototypical or reference architectures for important families of software applications, such as those used in Internet commerce, manufacturing, biomedical control, and avionics, and to derive general principles and methodologies such as formal verification for the design of complex software systems.

Software Testing and Reliability - Professors White and Podgurski

This research focuses on improving the quality of software. One approach to testing software is to identify and correct defects applied to object-oriented software and specifically to GUI systems. Also there is a research project on data coverage testing, where the emphasis is to predict when testing can be stopped, as further testing can be shown to be only marginal in effectiveness.

Space Communications and Networks - Professors Ergun, Kinman, Ko, Malakooti, Merat, G. Ozsoyoglu, M. Ozsoyoglu, Papachrostou, Phillips, Sahinalp and Young

This research is primarily concerned with developing communications and networking solutions for near- and deep-space applications. Current research includes: (1) MEMS tunable antennas for power efficient wireless communications; (2) miniature silicon optical reflectors which can be electrostatically deformed and steered; (3) tiled arrays of processors which can be reconfigured for a variety of communications and signal processing applications; (4) semantic-based database inquiry and data warehousing for space assets; (5) protocols and control architectures for remote teleoperation of robots; (6) protocols and systems for the intelligent routing of data in space networks; (7) wireless networks of biosensors for monitoring of astronauts; and (8) efficient utilization of radio spectrum for space communications, performance modeling of radio communications using advanced coding schemes, Doppler and range measurements to space vehicles.

Facilities

Computer Facilities

The department computer facilities incorporate both UNIX (primarily Solaris) and Microsoft Windows-based operating systems on high end computing workstations for its educational and research labs. A number of file, printing, database and authentication servers support these workstations as well as the administrative functions of the department. Labs are primarily located in the Olin, Glennan and Smith buildings and are connected to each other via CWRUnet.

CWRUnet is a state-of-the-art, high-speed fiber optic campus-wide computer network that interconnects laboratories, faculty and student offices, classrooms and student residence halls at the University. CWRUnet is one of the largest fiber-to-desktop networks anywhere in the world. Every desktop has or will have a 1 Gbps (gigabit per second) connection to the rest of the campus network backbone, which runs on fault-tolerant 10 Gbps and faster fiber-optic links. In an effort to expand network availability to complement the wired network already in place, more than 1,000 wireless access points (WAPs) are being deployed, allowing students with laptops and wireless enabled PDAs to access CWRUnet resources from practically anywhere on campus.

Off campus users, through the use of CWRUnet's high capacity virtual private network (VPN) servers, can use their home dial-up or broadband connections to access many on campus resources as well as software as if they were physically connected to CWRUnet.

The department and the University also participate in the Internet2 project, which provides a high-speed, inter-University network infrastructure allowing for enhanced collaboration between institutions. The Internet2 infrastructure allows students, faculty and staff alike the ability to enjoy extremely high performance connections to other Internet2 member institutions.

Aside from standard services provided through a commodity Internet connection, CWRUnet users can take advantage of numerous on-line databases such as EUCLIDplus, the University Libraries' circulation and public access catalog, as well as Lexus-Nexus™ and various CD-ROM based dictionaries, thesauri, encyclopedias, and research databases. Many regional and national institutional library catalogs are accessible over the network, as well.

Department Laboratories

Smith Computer Lab

General purpose computer facilities for undergraduate instruction is provided by the Smith Laboratory which contains about 70 PCs, a number of Macintosh power PCs and ten SUN Sparc-5 UNIX workstations.

Jennings Computer Center Labs

Supported by an endowment from the Jennings Foundation, these labs provide our students with the education resources necessary both for their classes and to explore their interest in the art of computing.

Database and Multimedia Laboratory

Primarily funded by NSF equipment grants, this laboratory provides specialized equipment for research into multimedia and database systems.

VLSI Design Laboratory

Supported by the Silicon Research Corporation and industry, this laboratory has a number of UNIX workstations which run CAD software for VLSI design. This laboratory is currently used to develop testing techniques for digital design.

Autonomous Robotics Laboratory

Primarily funded by ONR and other federal sources, this laboratory has a number of computer workstations and robots which are used to conduct research into robotics, autonomous agents and biological simulation.

Electronic Circuits Lab

This laboratory has been primarily supported by the Hewlett-Packard Company and is the basic resource for students taking analog, digital and mixed-signal electronics classes. All instrumentation in the lab is computer-interfaced and students can even conduct experiments from their dorm rooms.

Analog Workstations

266 MHz NT workstations are equipped with LabView software. The workstations have HP-IB instrument interfaces connected to Hewlett-Packard 546xx oscilloscopes, 33120A Waveform Generators, 34401A Digital Multimeters, and E3631A power supplies.

Digital Workstations

450 MHz NT workstations and Sun Workstations support Xylinx FPGA hardware/software.

Additional instrumentation includes a Hewlett-Packard 4155B semiconductor parameter, Hewlett-Packard 54616TC mixed-signal test stations, Hewlett Packard logic analyzers, and Hewlett-Packard high-frequency oscilloscopes.

Lester J. Kern Computational Laboratory

This laboratory is used by students enrolled in "Electromechanical Energy Conversion," as well as for research in robotics and mechatronics. Laboratory facilities include: four lab stations for demonstrating machine characteristics and basic steady-state and dynamic system performance, four Sun SPARC UNIX workstations, and real-time data acquisition systems for interaction with lab experiments and control of machines.

Microcomputer Laboratory

This laboratory contains approximately 25 Microcomputers (these are mostly high end Pentiums and a few Macintosh Power PC's), along with a complement of laser printers, network connections (university fiber optic network and LAN), and scientific software (MATLAB, VISSIM, Mathematica, GINO, LINDO, etc.).

Process Control Laboratory

This laboratory contains process control pilot plants, computerized hardware for process control and demonstration/research facilities. This wet lab has access to steam and compressed air for use in the pilot plants.

Timken Foundation Dynamics and Control Laboratory

Contains mechanical, pneumatic and electrical laboratory experiments for teaching and research purposes. This includes PLCs, motors and robotics systems.

Global Systems Laboratory

This laboratory consists of various PC and Sun Sparc workstations containing databases from the UN, World Watch Institute, World Resources Institute, U.S. Government, etc., and policy and scenario analysis software.

Rockwell Automation Machinery Diagnostics and Control Laboratory

This laboratory is focused upon machinery diagnostics and failure prediction. Several test stands will provide instrumentation for machinery lifetime prediction and sensor development. Additional instrumentation will provide for remote operation of the test stands.

Micro-electronic Device Modeling and Characterization Lab

Affiliated with our MicroFabrication Laboratory MFL, this laboratory is equipped with dc measurement capabilities for evaluating semiconductor device performance. Device modeling is done on Sun SPARC and HP workstations.

Hans Jaffe Ultrasonics Laboratory

This laboratory is dedicated to the study and fabrication of specialized ultrasonic transducers. Facilities include pulsar receivers, specialized scopes, precision signal generators, and piezoelectric devices.

Center for Automation and Intelligent Systems Research

Supported in part by CAMP, Inc. through the State of Ohio's Thomas Edison research center program, this educational and research center contains multiple laboratories including:

• Mechatronics Laboratory
• Intelligent Systems Laboratory
• Multimedia and Computations Intelligent Systems Laboratory
• Control and Signal Processing Laboratories.

These laboratories are equipped with a diverse range of modern scientific and CAD workstations, computer controlled robots, materials handling devices, image processing and computer vision systems. These laboratories support research activities in robotics, agile manufacturing, multimedia internet applications to manufacturing, rotating machinery diagnostics, optical sensing and process control.

MicroFabrication Laboratory

This laboratory has been funded by many agencies including the State of Ohio and DARPA. The MicroFabrication Laboratory (MFL) is a state-of-the-art clean room facility for the fabrication of microelectromechanical systems (MEMS) and microelectronic devices. The Class 100 facility supports the University's strong interdisciplinary MEMS research program by providing on-campus fabrication capabilities for a broad range of research projects by investigators from a number of departments within the university; it is also accessible by external organizations for prototype fabrication and R&D. The MFL offers a broad spectrum of micromachining processes, including bulk and surface micromachining, wafer bonding, and micro-molding. These capabilities are augmented by a 2-micron CMOS process for the fabrication of integrated microsensors/microactuators.

The Center for Computational Genomics

Established by a $2.2 million grant from the Charles B. Wang Foundation, Inc. this interdisciplinary center (EECS, Genetics, and Biostatistics & Epidemiology) employs computer science to analyze the function of genes and proteins in health and disease. The Center's lab provides high-power computing resources (2GHz Dells with 1 GB DRAM) for computational genomics research.

PLC Control and Automation Laboratory

This laboratory uses Allen-Bradley PLC's for data acquisition and real-time control of complex processes. Currently the PLCs control a multi-train HO model system and a five-floor, two-car elevator system.

ENGR 131 Freshman Computing Lab

This lab is used to support the freshman ENGR 131 Elementary Computer Programming class. The laboratory provides personal computers and Lego Mindstorm robot kits which freshman use to learn about how computers can be used to control mechanisms, as well as to study C/C++ programming.

Undergraduate Programs

Electricial Engineering

The undergraduate program in electrical engineering, which leads to the Bachelor of Science in Engineering degree, provides a broad foundation in electrical engineering through combined classroom and laboratory work and prepares the student for entering the profession of electrical engineering as well as for further study at the graduate level.

Core courses provide the student with a strong background in mathematics, physical sciences and the fundamentals of engineering. Each electrical engineering student must take the following core courses:

Breadth Requirements:

• ENGR 131 Elementary Computer Programming
• ENGR 210 Introduction to Circuits and Instrumentation
• EECS 281 Logic Design and Computer Organization
• EECS 245 Electronic Circuits
• EECS 246 Signals and Systems
• EECS 309 Electromagnetic Fields I

- STAT 332 Statistics of Signal Processing
- EECS 321 Semiconductor Electronic Devices
- EECS 398L
- EECS 399L

Depth Requirement:

Each student must show a depth of competence in one technical area by taking at least three courses from one of the following seven areas. Note that this depth requirement may be met using a combination of the above core courses and a selection of open and technical electives.

Area I: Electromagnetics

EECS 309 Electromagnetic Fields I
EECS 310 Electromechanical Energy Conversion
EECS 311 Electromagnetic Fields II

Area II: Signals & Systems

EECS 246 Signals and Systems
EECS 313 Signal Processing
EECS 347 Network Synthesis
EECS 351 Communications and Signal Analysis
EECS 354 Digital Communications
EECS 396 Hybrid Systems

Area III: Computer Software

EECS 233 Data Structures
EECS 337 Systems Programming
EECS 338 Operating Systems

Area IV: Solid State

EECS 321 Semiconductor Electronic Devices
EMSE 314 Electrical, Optical and Magnetic Properties of Matter
EECS 322 Integrated Circuits and Electronic Devices

Area V: Control

EECS 304 Control Engineering I
EECS 310 Electromechanical Energy Conversion
EECS 383 Microprocessor Applications to Control
EECS 346 Engineering Optimization
EECS 396 Hybrid Systems

Area VI: Circuits

EECS 245 Electronic Circuits
EBME 310 Biomedical Instrumentation
EECS 344 Electronic Circuit Design
EECS 382 Microprocessor Based Design
EBME 418 Biomedical Electronics
EECS 426 MOS Integrated Circuit Design

Area VII: Computer Hardware

EECS 281 Computer Organization
EECS 382 Microprocessor Based Design
EECS 301 Computer Design Lab
EECS 314 Computer Architecture
EECS 315 Digital Systems Design

Statistics Requirement:

- STAT 332 Statistics of Signal Processing (STAT 333 may be substituted for STAT 332 with approval of advisor)
- Applied Statistics Elective (Class which uses statistics in some aspect of electrical engineering. Student may choose from EECS 351, EECS 354 or other class approved by advisor.)

Design Requirement:

- EECS 398L Senior Project I
- EECS 399L Senior Project II

In consultation with a faculty advisor, the student completes the program by selecting technical and open elective courses that provide in-depth training in one or more of a variety of specialties such as digital and microprocessor-based control, communications and electronics, solid state electronics and integrated circuit design and fabrication. With the approval of their advisors students may emphasize other specialties by selecting elective courses from other programs or departments.

Many courses have integral or associated laboratories in which students gain “hands-on” experience with electrical engineering principles and equipment. Students have ready access to the laboratory facilities and are encouraged to work in the various laboratories during nonscheduled hours in addition to the regularly scheduled laboratory sessions. Opportunities also exist for undergraduate student participation in many of the wide variety of research projects being conducted within the program.

Minor in Electrical Engineering

Students enrolled in degree programs in other engineering departments can have a minor specialization by completing the following courses:

- EECS 245 Electronic Circuits I (4)
- EECS 246 Signals and Systems (4)
- EECS 281 Logic Design and Computer Organization (4)
- EECS 309 Electromagnetic Fields I (3)
- Approved Technical Elective (3)

Minor in Electronics

The department also offers a minor in electronics for students in the College of Arts and Science. This program requires the completion of 29 credit hours, of which 10 credit hours may be used to satisfy portions of the students’ skills and distribution requirements. The following courses are required for the electronics minor:

- MATH 125 Mathematics I (4)
- MATH 126 Mathematics II (4)
- PHYS 115 Introductory Physics I (4)
- PHYS 116 Introductory Physics II (4)
- ENGR 131 Elementary Computer Programming (3)
- ENGR 210 Circuits and Instrumentation (4)
- EECS 246 Signals and Systems (4)
- EECS 281 Logic Design and Computer Organization (4)

Cooperative Education Program

There are many excellent Cooperative Education (CO-OP) opportunities for computer engineering majors. A CO-OP student does two CO-OP assignments in industry or government. The length of each assignment is a semester plus a summer which is enough time for the student to complete a significant computing project. The CO-OP program takes five years to complete because the student is typically gone from campus for two semesters.

B.S./M.S. Program

The department encourages students with at least a 3.5 grade point average to apply for admission to the five-year bachelors/master’s program in the junior year. This integrated program, which permits substitution of M.S. thesis work for the senior design project, provides a high level of fundamental training and in-depth advanced training in the student’s selected specialty. It also offers the opportunity to complete both the Bachelor of Science in Engineering and Master of Science degrees within five years.

Computer Engineering

The Bachelor of Science program in Computer Engineering is designed to give a student a strong background in the fundamentals of mathematics, physics, and computer engineering and science. A graduate of this program should be able to use these fundamentals to analyze and evaluate computer systems, both hardware and software. A graduate should also be able to design and implement computer systems, both hardware and software, which are state of the art solutions to a variety of computing problems. This includes systems which have both a hardware and a software component, whose design requires a well defined interface between the two, and the evaluation of the associated engineering trade-offs. In addition to these program specific objectives, all students in the EECS department are exposed to societal issues, professionalism, and have the opportunity to develop leadership skills.

Minor In Computer Engineering

The minor has a required two course sequence followed by a two course sequence in either hardware or software aspects of computer engineering.

The following two courses are required for any minor in computer engineering:

- EECS 281 Logic Design and Computer Organization (or equivalent)
- EECS 233 Introduction to Data Structures

The two-course hardware sequence is:

- EECS 314 Computer Architecture
- EECS 315 Digital Systems Design

The corresponding two-course software sequence is:

- EECS 337 Systems Programming
- EECS 338 Introduction to Operating Systems

In addition to these two standard sequences, the student may design his/her own with the approval of the minor advisor. A student cannot have a major and a minor, or two minors, in both Computer Engineering and Computer Science because of the significant overlap between these subjects.

Cooperative Education Program

There are many excellent Cooperative Education (CO-OP) opportunities for computer engineering majors. A CO-OP student does two CO-OP assignments in industry or government. The length of each assignment is a semester plus a summer which is enough time for the student to complete a significant computing project. The CO-OP program takes five years to complete because the student is typically gone from campus for two semesters.

B.S./M.S. Program

Students with a grade point average of 3.2 or higher are encouraged to apply to the B.S./M.S. Program which will allow them to get both degrees in five years. The B.S. can be in Computer Engineering or a related discipline, such as mathematics or electrical engineering. Integrating graduate study in computer engineering with the undergraduate program allows a student to satisfy all requirements for both degrees in five years.

Computer Science

The Bachelor of Science program in Computer Science is designed to give a student a strong background in the fundamentals of mathematics and computer science. A graduate of this program should be able to use these fundamentals to analyze and evaluate software systems and the underlying abstractions upon which they are based. A graduate should also be able to design and implement software systems which are state of the art solutions to a variety of computing problems; this includes problems which are sufficiently complex to require the evaluation of design alternatives and engineering trade-off’s. In addition to these program specific objectives, all students in the EECS department are exposed to societal issues, professionalism, and have the opportunity to develop leadership skills.

The Bachelor of Arts program in Computer Science is a combination of a liberal arts program and a computing major. It is a professional program in the sense that graduates can be employed as computer professionals, but it is much less technical than the Bachelor of Science program in Computer Science. It is particularly suitable for students with a wide variety of interests. For example, students can major in another discipline in addition to computer science and routinely complete all of the requirements for the double major in a 4 year period. This is possible because over a third of the courses in the program are open electives. Furthermore, if a student is majoring in computer science and a second technical field such as mathematics or physics many of the technical electives will be accepted for both majors. Another example of the utility of this program is that it routinely allows students to major in computer science and take all of the pre-med courses in a 4 year period.

Minor In Computer Science (B.S. or B.S.E.)

For students pursuing a B.S. or B.S.E. degree, the following three courses are required for a minor in computer science:

- EECS 233 Introduction to Data Structures
- EECS 338 Introduction to Operating Systems
- EECS 340 Algorithms and Data Structures

A student must take an additional four credit hours of computing courses with the exclusion of ENGR 131. MATH 304 (Discrete Mathematics) may be used in place of three of these credit hours because it is a prerequisite for EECS 340.

Minor In Computer Science (B.A.)

For students pursuing B.A. degrees, the following courses are required for a minor in computer science:

- ENGR 131 Elementary Computer Programming
- EECS 233 Introduction to Data Structures
- MATH 125 Mathematics I

Two additional computing courses are also required for this minor.

Cooperative Education Program

There are many excellent Cooperative Education (CO-OP) opportunities for computer science majors. A CO-OP student does two CO-OP assignments in industry or government. The length of each assignment is a semester plus a summer which is enough time for the student to complete a significant computing project. The CO-OP program takes five years to complete because the student is typically gone from campus for two semesters.

B.S./M.S. Program

Students with a grade point average of 3.2 or higher are encouraged to apply to the B.S./M.S. Program which will allow them to get both degrees in five years. The B. S. can be in Computer Science or a related discipline, such as mathematics or electrical engineering. Integrating graduate study in computer science with the undergraduate program allows a student to satisfy all requirements for both degrees in five years.

Systems and Control Engineering

The systems and control engineering B.S. program provides the student with the basic concepts, analytical tools, and engineering methods which are useful in analyzing and designing complex technological and non-technological systems. Problems relating to modeling, decision-making, control, and optimization are studied. Some examples of systems problems which are studied include: computer control of industrial plants, development of world models for studying environmental policies, and optimal planning and management in large-scale systems. In each case, the relationship and interaction among the various components of a given system must be modeled. This information is used to determine the best way of coordinating and regulating their individual contributions to achieve the overall goal of the system. What may be best for an individual component of the system may not be the best for the system as a whole.

There are three elective sequences available within our B.S. degree curriculum:

Control Systems

The Control Systems sequence is directed toward developing skills in dynamic system modeling, analysis, automation, remote control, real-time data acquisition and feedback control.

Systems Analysis

The Systems Analysis sequence focuses on modeling, optimization, decision making and planning methods.

Industrial and Manufacturing Systems

The Industrial and Manufacturing Systems sequence provides education in the application of systems analysis, decision making and automation methods to industrial production and manufacturing problems.

All three sequences use concepts of modeling, data analysis, computer simulation, and optimization. Computers play a central role in the systems and control curriculum, not only for engineering and mathematical computation, but also for computer simulation, automatic control, real-time data acquisition and signal processing.

Minor Program In Systems and Control Engineering

A total of five courses (15 credit hours) are required to obtain a minor in systems and control engineering.

At least nine credit hours must be selected from:

- EECS 212 Signals, Systems and Control (3)
- EECS 214 Signals, Systems and Control Lab (1)
- EECS 304 Control Engineering I with Laboratory (3)
- EECS 346 Engineering Optimization (3)
- EECS 352 Engineering Economics and Decision Analysis (3)

The remaining credit hours can be chosen from EECS courses with the written approval of the faculty member in charge of the minor program in the Systems and Control Program. A list of suggested EECS courses to complete the minor is:

- EECS 110 Problem Solving & Systems Engineering
- EECS 324 Simulation Methods in Engineering
- EECS 313 Signal Processing
- EECS 306 Control Engineering II
- EECS 350 Production and Operational Systems
- EECS 360 Manufacturing and Integrated Systems

Cooperative Education Program

There are many excellent Cooperative Education (CO-OP) opportunities for systems and control engineering majors. A CO-OP student does two CO-OP assignments in industry or government. The length of each assignment is a semester plus a summer which is enough time for the student to complete a significant engineering project. The CO-OP program takes five years to complete because the student is typically gone from campus for two semesters.

B.S./M.S. Program

The department encourages students with at least a 3.2 grade point average to apply for admission to the five-year bachelors/master's program in the junior year. This integrated program, which permits substitution of M.S. thesis work for the senior design project, provides a high level of fundamental training and in-depth advanced training in the student's selected specialty. It also offers the opportunity to complete both the Bachelor of Science in Engineering and Master of Science degrees within five years.

Control Engineering and Signal Processing

EECS 306 Control Engineering II
EECS 396 Hybrid Systems
EECS 401 Digital Signal Processing
EECS 404 Digital Control
EECS 409 Discrete Event Systems
EECS 417 Introduction to Stochastic Control

Control Systems Analysis and Engineering

EECS 414 Complex Systems Modeling and Analysis
EECS 416 Engineering Optimization
EECS 429 Risk and Decision Analysis
OPRE 432 Simulation
OPRE 426 Stochastic Processes in Operations Research

Manufacturing, Industrial, and Operational Systems

EECS 350 Production and Operational Systems

EECS 360 Manufacturing and Integrated Systems
OPMT 351 Logistical Systems
OPMT 353 Quality Control and Management
EECS 450 Production and Operational Systems
EECS 460 Manufacturing and Integrated Systems
OPRE 424 Scheduling

Graduate Programs

Computer Engineering and Science Graduate Studies

The programs in computer engineering and computing and information sciences are similar in that they each require a strong background in both computer hardware and software, as well as a substantial amount of "hands-on," experience. The programs differ in that engineering is based mainly in physical sciences, while computer science is more strongly based in mathematical sciences as applied to more abstract notions such as properties of programming languages, analysis of algorithms, complexity considerations, and proof of correctness. The department believes that the success of its graduates at all levels is largely due to the emphasis on project and problem-oriented course material coupled with the broad-based curricular requirements. Doctoral dissertations must be original contributions to the existing body of knowledge in computer engineering and science.

Electrical Engineering and Applied Physics Graduate Studies

The electrical engineering program offers graduate study leading to the Master of Science and Doctor of Philosophy degrees. The programs are comprehensive and basic, emphasizing four major areas in which the faculty are actively engaged in research: (1) automation, sensing, intelligence and actuation; (2) solid state electronics; (3) electromagnetic, high frequency communications and devices; and (4) circuits, signal processing, and computer-aided design. Academic requirements for graduate degrees in engineering are as specified for The Case School of Engineering in this bulletin, however, some exceptions are noted below. All current rules and regulations for this department are detailed in a graduate student handbook, available from the department office, which supersedes any rules contained here. A number of teaching and research assistantships are available, on a competitive basis, for the full support of qualified students. In addition, a limited number of tuition assistantships are also available for partial support of graduate students.

Systems Engineering Graduate Studies

Graduate programs in systems and control engineering include the following areas of concentration: control theory (adaptive control, stochastic filtering and control, nonlinear control), optimization and decision theory (multi-objective and large scale system theory), control of industrial and manufacturing systems (facilities layout, flexible manufacturing), biomedical control system design and analysis (control of neural prostheses, automatic control of therapeutic drug delivery), energy systems (power distribution and production planning, load forecasting), and global and environmental system analysis and control.(resource constraints: water, energy etc., carrying capacity and global climate change).

Research funds are used to provide assistantships that support the thesis research of graduate students. Current research funding is provided by Elsag-Bailey, Rockwell Automation, the Ford Motor Company, the Cleveland Advanced Manufacturing Program (CAMP), the Electric Power Research Institute (EPRI), the National Institutes of Health (NIH), National Institute of Nursing Research(NINR),the National Science Foundation (NSF), the U.S. Department of Veterans Affairs-Rehabilitation Research and Development Program (VA-RR&D), the Office of Naval Research (ONR), the U.S. Agency for International Development

(US-AID) and United National Education, Scientific Cultural Organization (UNESCO).

Bachelor of Science in Engineering Degree Major in Electrical Engineering

Freshman Year   Class-Lab-Credit Hours

Fall

HM/SS elective ....(3-0-3)
CHEM 111 Chemistry I ....(4-0-4)
MATH 121 Calculus I ....(4-0-4)
ENGR 131 Elementary Computer Programming (3-0-3)
ENGL 150 Expository Writing ....(3-0-3)
PHED 101 Physical Education ....(0-3-0)
Total ....(17-3-17)

Spring

Open elective [a] ....(3-0-3)
ENGR 145 Chemistry of Materials ....(4-0-4)
PHYS 121 Physics I: Mechanics [b] ....(4-0-4)
MATH 122 Calculus II ....(4-0-4)
PHED 102 Physical Education ....(0-3-0)
Total ....(15-3-15)

Sophomore Year

Fall

PHYS 122 Physics II Electricity & Magnetism (4-0-4)
MATH 223 Calculus III ....(3-0-3)
ENGR 210 Circuits and Instrumentation ..(3-2-4)
EECS 281 Computer Organization, Logic Design (3-2-4)
Total ....(13-4-15)

Spring

HM/SS Sequence I ....(3-0-3)
ENGR 225 Thermo, Fluids, Transport .....(4-0-4)
MATH 224 Differential Equations ....(3-0-3)
EECS 245 Electronic Circuits ....(3-2-4)
EECS 309 Electromagnetic Fields I ......(3-0-3)
Total ....(16-2-17)

Junior Year   Class-Lab-Credit Hours

Fall

HM/SS Sequence II ....(3-0-3)
ENGR 200 Statics & Strength of Materials (3-0-3)
EECS 246 Signals & Systems ....(3-2-4)
STAT 332 Statistics of Signal Processing [c] (3-0-3)
Approved Tech. Elective [d] ....(3-0-3)
Total ....(15-2-16)

Spring

HM/SS Sequence III ....(3-0-3)
EECS 321 Semiconductor Elect. Devices ..(3-2-4)
Applied Statistics Req.[e] ....(3-0-3)
Approved technical elective [d] ....(3-0-3)
Approved technical elective [d] ....(3-0-3)
Total ....(15-2-16)

Senior Year

Fall

EECS 398L Senior Project Lab I [f, g] .....(0-8-4)

ENGL 398N Professional Communications .. (3-0-3)
Open Elective .... (3-0-3)
Approved technical elective [d] .... (3-0-3)
Approved technical elective [d] .... (3-0-3)
Total .... (12-8-16)

Spring
HM/SS elective .... (3-0-3)
HM/SS elective .... (3-0-3)
EECS 399L Senior Project Lab II .... (0-8-4)
Open elective .... (3-0-3)
Approved technical elective [d] .... (3-0-3)
Total .... (12-8-16)

Graduation Requirement: 128 hours total

a. Although not required students may elect to take ENGR 101 Freshman Engineering Field Service Project as their open elective in the freshman year.
b. Selected students may be invited to take PHYS 123, 124 in place of PHYS 121 and PHYS 122.
c. Students may replace this class with STAT 333 Uncertainty in Engineering and Science if approved by their advisor.
d. Technical electives will be chosen to fulfill the depth requirement and otherwise increase the student’s understanding of electrical engineering. Courses used to satisfy the depth requirement must come from the department’s list of depth areas and related courses. Technical electives not used to satisfy the depth requirement are more generally defined as any course related to the principles and practice of electrical engineering. This includes all EEAP courses at the 200 level and above and can include courses from other programs. All non-EEAP technical electives must be approved by the student’s advisor.
e. This course must utilize statistics in electrical engineering applications and is typically EEAP 352 Digital Communications or EEAP 355 RF Communications. Other courses possible with approval of advisor.
f. Co-op students may obtain design credit for one semester of Senior Project Lab if their co-op assignment included significant design responsibility; however, the student is still responsible for such course obligations as reports, presentations and ethics assignments. Design credit and fulfillment of remaining course responsibilities are arranged through the senior project instructor.
g. B.S./M.S. students may also utilize EEAP 398/399 to fulfill eight credits of M.S. thesis provided their thesis has adequate design content to meet the requirements of EEAP 398/399. B.S./M.S. students should see their thesis advisor for details.

Bachelor of Science in Engineering Degree
Major in Computer Engineering

Freshman Year   Class-Lab-Credit Hours

Fall
Open elective or HM/SS elective [a] .... (3-0-3)
CHEM 111 Chemistry I .... (4-0-4)
MATH 121 Calculus I .... (4-0-4)
ENGR 131 Elementary Computer Programming (3-0-3)
ENGL 150 Expository Writing .... (3-0-3)
PHED 101 Physical Education .... (0-3-0)
Total .... (17-3-17)

Spring
HM/SS elective or open elective [a] ...... (3-0-3)
ENGR 145 Chemistry of Materials .... (4-0-4)
PHYS 121 Physics I: Mechanics .... (4-0-4)
MATH 122 Calculus II .... (4-0-4)
PHED 102 Physical Education .... (0-3-0)
Total .... (15-3-15)

Sophomore Year

Fall
HM/SS Sequence I ....(3-0-3)
PHYS 122 Physics II: Electricity & Magnetism (4-0-4)
MATH 223 Calculus III ....(3-0-3)
ENGR 200 Statics & Strength of Materials (3-0-3)
EECS 233 Introduction to Data Structures (3-2-4)
Total ....(16-2-17)

Spring
HM/SS Sequence II ....(3-0-3)
MATH 224 Differential Equations ....(3-0-3)
ENGR 210 Circuits and Instrumentation ..(3-2-4)
Technical Elective [b] ....(3-0-3)
EECS 281 Comp. Organization Logic Design (3-2-4)
Total ....(15-4-17)

Junior Year   Class-Lab-Credit Hours

Fall
HM/SS Sequence III ....(3-0-3)
MATH 304 Discrete Mathematics ....(3-0-3)
EECS 337 Systems Programming ....(3-2-4)
ENGR 225 Thermodynamics, Fluids, Transport (4-0-4)
Technical elective [b] ....(3-0-3)
Total ....(16-2-17)

Spring
ENGL 398N Prof. Communications ....(3-0-3)
EECS 301 Digital Laboratory ....(0-4-2)
EECS 314 Computer Architecture ....(3-0-3)
EECS 315 Digital Systems Design ....(3-2-4)
EECS 338 Intro to Operating Systems [d] ..(3-2-4)
or
Technical elective [d] ....(3-0-3)
Total ....(12-8-16) or (12-6-15)

Senior Year

Fall
HM/SS elective ....(3-0-3)
EECS 318 VLSI/CAD [d] ....(3-2-4)
or
Technical elective [c] ....(3-0-3)
Technical elective [b] ....(3-0-3)
Statistics elective ....(3-0-3)
Open elective ....(3-0-3)
Total ....(15-2-16) or (15-0-15)

Spring
HM/SS elective ....(3-0-3)
EECS 399M Comp. Eng. Design Project ....(0-6-3)
Technical elective [b] ....(3-0-3)
Open elective ....(3-0-3)
Open elective ....(3-0-3)
Total ....(12-6-15)

Graduation Requirement: 129 hours total

a. One of these must be a humanities/social science course
b. Technical electives are more generally defined as any course related to the principles and practice of computer engineering. This includes all EECS courses at the 200 level and above and can include courses from other programs. All non-EECS technical electives must be approved by the student’s advisor.
c. The student must take either EECS 318 VLSI/CAD (Fall Semester) or EECS 338 Intro. to Operating Systems (Spring Semester), AND a three credit hour technical elective.

d. Chosen from MATH 380 Introduction to Probability, STAT 312 Basic Statistics for Engineering and Science, STAT 313 Statistics for Experimenters, STAT 332 Statistics for Signal Processing, STAT 333 Uncertainty in Engineering and Science.

Bachelor of Science Degree
Major in Computer Science

Freshman Year   Class-Lab-Credit Hours

Fall

Open elective or HM/SS elective .... (3-0-3)
CHEM 111 Chemistry I .... (4-0-4)
MATH 121 Calculus I .... (4-0-4)
ENGR 131 Elementary Computer Programming (3-0-3)
ENGL 150 Expository Writing .... (3-0-3)
PHED 101 Physical Education .... (0-3-0)
Total .... (17-3-17)

Spring

HM/SS elective or open elective .... (3-0-3)
ENGR 145 Chemistry of Materials .... (4-0-4)
PHYS 121 Physics I: Mechanics .... (4-0-4)
MATH 122 Calculus II .... (4-0-4)
PHED 102 Physical Education .... (0-3-0)
Total .... (15-3-15)

Sophomore Year

Fall

HM/SS Sequence I .... (3-0-3)
PHYS 122 Physics II Electricity & Magnetism (4-0-4)
MATH 223 Calculus III .... (3-0-3)
Technical elective [b] .... (3-0-3)
ECES 281 Comp. Organization Logic Design (3-2-4)
Total .... (16-2-17)

Spring

HM/SS Sequence II .... (3-0-3)
MATH 224 Differential Equations .... (3-0-3)
Technical Elective [c] .... (3-0-3)
MATH 304 Discrete Mathematics .... (3-0-3)
EECS 233 Intro Data Structures .... (3-2-4)
Total .... (15-2-16)

Junior Year   Class-Lab-Credit Hours

Fall

HM/SS Sequence III .... (3-0-3)
EECS 340 Algorithms and Data Structures (3-0-3)
EECS 337 Systems Programming .... (3-2-4)
Statistics elective [c] .... (3-0-3)
Technical elective [c] .... (3-0-3)
Total .... (15-2-16)

Spring

HM/SS elective .... (3-0-3)
EECS 345 Programming Language Concepts . (3-0-3)
EECS 343 Theoretical Computer Science .. (3-0-3)
EECS 314 Computer Architecture .... (3-0-3)
EECS 338 Intro to Operating Systems .... (3-2-4)

Total ....(15-2-16)

Senior Year

Fall

ENGL 398N Professional Communication ... (3-0-3)
EECS 398M Software Engineering .... (3-0-3)
Technical elective [e] .... (3-0-3)
Open elective .... (3-0-3)
Open elective [d] .... (3-0-3)
Total ....(15-0-15)

Spring

HM/SS elective .... (3-0-3)
EECS 341 Intro. to Database Systems .... (3-0-3)
EECS 391 Intro. to Artificial Intelligence (3-0-3)
Technical elective [e] .... (3-0-3)
Open elective .... (3-0-3)
Total ....(15-0-15)

Graduation Requirement: 127 hours total

a. One of these must be a humanities/social science course.
b. ENGR 210 is recommended because it provides flexibility in choice of major and advanced EECS courses.
c. Chosen from MATH 380 Introduction to Probability, STAT 312 Basic Statistics for Engineering and Science, STAT 313 Statistics for Experimenters, STAT 332 Statistics for Signal Processing, STAT 333 Uncertainty in Engineering and Science.
d. Course other than mathematics or computer science.
e. Technical electives are more generally defined as any course related to the principles and practice of computer science. This includes all EESC and MATH courses at the 200 level and above and can include courses from other programs. All technical electives which are not EECS or MATH courses must be approved by the students advisor.

Bachelor of Arts Degree Computer Science

Freshman Year   Class-Lab-Credit Hours

Fall

Open elective .... (3-0-3)
MATH 125 Mathematics I .... (4-0-4)
ENGR 131 Elementary Computer Programming (3-0-3)
GER course .... (3-0-3)
GER course .... (3-0-3)
PHED 101 Physical Education .... (0-3-0)
Total ....(16-3-16)

Spring

ENGL 150 Expository Writing .... (3-0-3)
MATH 126 Mathematics II .... (4-0-4)
GER course .... (3-0-3)
GER course .... (3-0-3)
Open elective .... (3-0-3)
PHED 102 Physical Education .... (0-3-0)
Total ....(16-3-16)

Sophomore Year

Fall

EECS 281 Comp. Organization Logic Design (3-2-4)
GER course .... (3-0-3)
Logic Design technical elective [a] ...... (3-0-3)
Open elective .... (3-0-3)

Open elective .... (3-0-3)
Total .... (15-2-16)

Spring
GER course .... (3-0-3)
MATH 304 Discrete Mathematics .... (3-0-3)
EECS 233 Intro Data Structures .... (3-2-4)
Open elective.......................... (3-0-3)
Open elective .... (3-0-3)
Total .... (15-2-16)

Junior Year   Class-Lab-Credit Hours

Fall
EECS 337 Systems Programming .... (3-2-4)
GER course .... (3-0-3)
Open elective .... (3-0-3)
Open elective .... (3-0-3)
Total .... (12-2-13)

Spring
EECS 338 Intro to Operating Systems .... (3-2-4)
EECS 341 Intro to Database Systems ..... (3-0-3)
EECS 314 Computer Architecture .... (3-0-3)
Open elective.......................... (3-0-3)
Total .... (12-2-13)

Senior Year

Fall
EECS 340 Algorithms and Data Structures (3-0-3)
Technical elective [a] .... (3-0-3)
GER course .... (3-0-3)
Open elective .... (3-0-3)
Open elective .... (3-0-3)
Total .... (15-0-15)

Spring
Technical elective [a] .... (3-0-3)
Open elective .... (3-0-3)
Open elective .... (3-0-3)
Open elective .... (3-0-3)
Open elective .... (3-0-3)
Total .... (15-0-15)

Graduation Requirement: 120 hours total

a. One technical elective must be a computer science course. The other two technical electives may be computer science, MATH or STAT courses.

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Freshman Year   Class-Lab-Credit Hours

Fall
HM/SS elective .... (3-0-3)
CHEM 111 Chemistry I .... (4-0-4)
MATH 121 Calculus I .... (4-0-4)
ENGR 131 Elementary Computer Programming (3-0-3)
ENGL 150 Expository Writing .... (3-0-3)
PHED 101 Physical Education .... (0-3-0)
Total .... (17-3-17)

Spring

Open elective [a] .... (3-0-3)
ENGR 145 Chemistry of Materials .... (4-0-4)
PHYS 121 Physics I: Mechanics [b] .... (4-0-4)
MATH 122 Calculus II .... (4-0-4)
PHED 102 Physical Education .... (0-3-0)
Total .... (15-3-15)

Sophomore Year

Fall

PHYS 122 Physics II: Electricity & Magnetism [b] (4-0-4)
MATH 223 Calculus III .... (3-0-3)
ENGR 210 Circuits and Instrumentation .. (3-2-4)
EECS 281 Computer Organization .... (3-2-4)
Total .... (13-4-15)

Spring

HM/SS Sequence I .... (3-0-3)
ENGR 225 Fluid and Thermodynamics ...... (4-0-4)
MATH 224 Differential Equations .... (3-0-3)
STAT xxx Statistical Methods Course [c] .. (3-0-3)
ENGR 200 Statics & Strength of Materials (3-0-3)
Total .... (16-0-16)

Junior Year Class-Lab-Credit Hours

Fall

HM/SS Sequence II .... (3-0-3)
EECS 246 Signals and Systems .... (3-2-4)
EECS 342 Introduction to Global Systems. (3-0-3)
EECS 324 Simulation Methods .... (3-0-3)
Approved technical elective [e] .... (3-0-3)
Total .... (15-2-16)

Spring

HM/SS Sequence III .... (3-0-3)
EECS 304 Control Engineering I .... (3-0-3)
EECS 305 Control Lab I .... (0-2-1)
EECS 346 Engineering Optimization ...... (3-0-3)
Approved technical elective .... (3-0-3)
Open elective.......................... (3-0-3)
Total .... (15-2-16)

Senior Year

Fall

HM/SS elective .... (3-0-3)
EECS 398N Senior Project Lab [d] .... (0-8-4)
ENGL 398N Professional Communications... (3-0-3)
EECS 352 Eng. Econ. & Dec. Analysis .... (3-0-3)
Approved technical elective [e] .... (3-0-3)
Total................................. 12-8-16

Spring

HM/SS elective......................... (3-0-3)
EECS 399N Engineering Projects Lab II .. (0-8-4)
Approved Technical Elective [e] .... (3-0-3)
Approved Technical Elective [e] .... (3-0-3)
Approved Technical Elective [e] .... (3-0-3)
Total .... (12-8-16)

Graduation Requirement: 127 hours total

a. Although not required, students may elect to take ENGR 101, Freshman Engineering Service Project, as their open elective during the freshman year.
b. Selected students may be invited to take PHYS 124 in place of PHYS 121 and 122.

c. Choose from STAT 312, STAT 332, STAT 333.

d. Co-op students may obtain credit for the first semester of Senior Project Lab if their co-op assignment includes significant design responsibility. This credit can be obtained by submitting a suitable written report and making an oral presentation on the co-op work in coordination with the senior project instructor.

e. Technical electives from an approved list.