ELECTRICAL ENGINEERING

http://www.uvm.edu/~cems/soe/

OVERVIEW

The Electrical Engineering (EE) program at the University of Vermont is at the forefront of research in the areas of digital signal processing, control systems, power and energy systems, wireless communications, and electronic circuit and system design and testing. This rigorous and focused program offers competitive funding and prepares graduate students for careers in research and technical leadership. Graduate students can contribute to interdisciplinary research within a broad range of applications, including power/energy, biomedical, aerospace, and transportation. In addition, the EE program partners with other academic units to offer M.S. and Ph.D. degrees in Materials Science and a Ph.D. degree in Biomedical Engineering.

DEGREES

Electrical Engineering AMP

Electrical Engineering M.S.

Electrical Engineering Ph.D.

FACULTY

Almassalkhi, Mads; Associate Professor, Department of Electrical and Biomedical Engineering; PHD, University of Michigan
Bates, Jason H. T.; Professor, Department of Electrical and Biomedical Engineering; DSC, Canterbury University; PHD, University of Otago
Chevalier, Samuel; Assistant Professor, Department of Electrical and Biomedical Engineering; PhD, Massachusetts Institute of Technology
Cipolla, Marilyn Jo; Professor, Department of Neurological Sciences; Chair, Department of Electrical and Biomedical Engineering; PHD, University of Vermont
Duffaut Espinosa, Luis; Assistant Professor, Department of Electrical and Biomedical Engineering; PHD, Old Dominion University
Frolik, Jeff L.; Professor, Department of Electrical and Biomedical Engineering; PHD, University of Michigan
Lee, Byung S.; Professor, Department of Computer Science; PHD, Stanford University
Ossareh, Hamid-Reza; Associate Professor, Department of Electrical and Biomedical Engineering, PHD; University of Michigan
Pandey, Amritanshu; Assistant Professor, Department of Electrical and Biomedical Engineering, PHD, Carnegie Mellon University
Wshah, Safwan; Associate Professor, Department of Computer Science; PHD, State University of New York at Buffalo
Xia, Tian; Professor, Department of Electrical and Biomedical Engineering; PHD, University of Rhode Island

Computer Engineering Courses

CMPE 5220. Advanced Computer Architecture. 3 Credits.
Provides a thorough and sophisticated examination of various hardware aspects of modern computers, including: virtual memory, instruction-set architectures, instruction-level parallelism through pipelining, caches and cache coherence, threads, vector processors, and GPUs. Prerequisites: Familiarity with topics of computer organization as would come from the equivalent of CS 2210 or CMPE 2210; Graduate student. Credit not awarded for both CMPE 5220 and CS 3220 or CMPE 3220. Cross-listed with: CS 5220.

CMPE 5410. Digital VLSI Circuit Design. 0 or 3 Credits.
Covers the techniques for the design, analysis and layout of digital CMOS circuits and systems. Major topics include MOSFET basics (structure and behavior of a MOSFET, CMOS fabrication, and design rules), detailed analysis of the CMOS circuits and systems (static behavior, ratioed vs. ratioless design), noise margins, computing rise and fall times, delay models, resistance. Prerequisite: Electrical Engineering Graduate student, Computer Science Graduate student, or Instructor permission. Cross-listed with: EE 5410.

CMPE 5540. Real-Time Control Systems. 3 Credits.
Digital control systems analysis and design. Topics include: difference equations, the Z-transforms, discrete-time transfer functions, state-space models, sampled-data systems, discretization, real-time control, microprocessor implementation, and optimal control. Project-based final. Prerequisite: Electrical Engineering Graduate student, Computer Science Graduate student, or Instructor permission. Cross-listed with: EE 5540.

CMPE 5610. Information Theory. 3 Credits.
Introduction to probability concepts of information theory; entropy of probability models; theoretical derivations of channel capacity; coding methods and theorems, sampling theorems. Prerequisite: Graduate student or Instructor permission. Cross-listed with: EE 5610, CS 5610.

CMPE 5810. Digital Computer Design. 3 Credits.
To gain a solid understanding of digital computer operating mechanisms and reconfigurable computing, and advance into hands-on experiences to design and debug digital computer system and embedded system. Field programmable gate arrays (FPGAs) will be utilized as the development platform. Prerequisite: Electrical Engineering Graduate student, Computer Science Graduate student, or Instructor permission. Cross-listed with: EE 5810, CS 5810.

CMPE 5990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

CMPE 5991. Internship. 1-18 Credits.
On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

CMPE 5993. Independent Study. 1-18 Credits.
A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CMPE 5994. Teaching Assistantship. 1-3 Credits.
Student service as a teaching assistant, usually in an introductory level course in the discipline, for which credit is awarded. Offered at department discretion.

CMPE 5995. Graduate Independent Research. 1-18 Credits.
Student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CMPE 6391. Master's Thesis Research. 1-18 Credits.
Research for Master?s Thesis.

CMPE 6392. Master's Project Research. 1-3 Credits.
Research for Master's Project.

CMPE 6990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

CMPE 6991. Internship. 1-18 Credits.
On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

CMPE 6993. Independent Study. 1-18 Credits.
A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CMPE 6994. Teaching Assistantship. 1-3 Credits.
Student service as a teaching assistant, usually in an introductory level course in the discipline, for which credit is awarded. Offered at department discretion.

CMPE 6995. Graduate Independent Research. 1-18 Credits.
Student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CMPE 7491. Doctoral Dissertation Research. 1-18 Credits.
Research for Doctoral Dissertation.

CMPE 7990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

CMPE 7991. Internship. 1-18 Credits.
On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

CMPE 7993. Independent Study. 1-18 Credits.
A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CMPE 7994. Teaching Assistantship. 1-3 Credits.
Student service as a teaching assistant, usually in an introductory level course in the discipline, for which credit is awarded. Offered at department discretion.

CMPE 7995. Graduate Independent Research. 1-18 Credits.
Student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

Electrical Engineering Courses

EE 5310. Power System Analysis. 3 Credits.
Transmission system modeling, operations and planning and energy policy are discussed to prepare students for the electricity and energy industry and power/energy systems research. Topics include: transmission line models, generator capability curves, transformer modeling and control, per-unit conversion, power flow calculations and software, smart grid. Prerequisite: Graduate Electrical Engineering student or Instructor permission.

EE 5410. Digital VLSI Circuit Design. 0 or 3 Credits.
Covers the techniques for the design, analysis and layout of digital CMOS circuits and systems. Major topics include MOSFET basics (structure and behavior of a MOSFET, CMOS fabrication, and design rules), detailed analysis of the CMOS circuits and systems (static behavior, ratioed vs. ratioless design), noise margins, computing rise and fall times, delay models, resistance. Prerequisite: Electrical Engineering Graduate student or Instructor permission. Cross-listed with: CMPE 5410.

EE 5430. RF Circuit Design. 3 Credits.
Design and analysis of radio frequency and microwave circuits. Covers radio frequency and microwave behavior of passive components, various transmission line structures, electromagnetic (EM) wave propagation in dielectric media, reflection coefficient and load impedance, network properties and applications, impedance matching network design, scattering parameters and their usage for RF. Prerequisite: Electrical Engineering Graduate student or Instructor permission.

EE 5440. Gr Semiconductor Materials/Dev. 0 or 4 Credits.
Covers energy band theory, effective mass, band structure and electronic properties of semiconductors. Transport of electrons and holes in bulk materials and across interfaces. MOSFETs, BJTs, pn junctions, and Schottky barriers. Experimental portion of course will have a laboratory component for electronic measurements of semiconductor devices. Credit not awarded for both EE 5440 and EE 3440. Prerequisite: Graduate student or Instructor permission. Cross-listed with: PHYS 5675.

EE 5460. Microelec. Circuit Fabrication. 0 or 4 Credits.
Provides a firm knowledge base in modern semiconductor fabrication technology. This technology lies at the heart of all modern computer and communication systems. Analyze and evaluate the unit processes involved in creating semiconductor chips such as photolithography, plasma etch, ion implant and metallization. Explore the current state-of-the-art and demonstrate how these building blocks affect the electrical behavior of semiconductor devices. Prerequisites: Electrical Engineering, Materials Science, Mechanical Engineering, or Physics Graduate student; or Instructor permission. Cross-listed with: PHYS 5165.

EE 5503. Modern Signal Processing. 3 Credits.
Covers principles and methods for digital signal processing. The analysis and design of discrete-time systems as signal processing devices is provided in the context of filter design, adaptive processing, compress sensing, and topics on image processing. Topics covered: quantization, reconstruction of signals, z-transform, FIR/IIR, compress sensing, compress sensing processing, intro to images, pixel and region-based classification, and segmentation, among others.

EE 5540. Real-Time Control Systems. 3 Credits.
Digital control systems analysis and design. Topics include: difference equations, the Z-transforms, discrete-time transfer functions, state-space models, sampled-data systems, discretization, real-time control, microprocessor implementation, and optimal control. Project-based final. Prerequisite: Electrical Engineering Graduate student or Instructor permission. Cross-listed with: CMPE 5540.

EE 5550. Autonomy I. 3 Credits.
Students learn how to make engineered systems autonomous/intelligent. Covers logic and algorithms, real-time estimation and control of dynamical systems, optimization and optimal planning, path planning for robots and autonomous vehicles, basics of artificial intelligence and machine learning, and ethics of automation. Applications include hover flight of quadrotor drones, perception and navigation of robots including robotic arms and self-driving vehicles, and autonomous control of the power grid. Prerequisites: Graduate student or Instructor permission; content knowledge of control systems (such as EE 3515) assumed.

EE 5560. Autonomy II. 3 Credits.
Covers principles and methods for perception and localization of autonomous robotic systems within a systematic software framework. The analysis and design of practical methods for the deployment of control, path planning, localization and mapping, and safety of autonomous systems are provided in the context of the Robotic Operative Systems (ROS). Topics covered: introduction to ROS; perception using RGB-D cameras and lidar; Kalman filters for state estimation; SLAM; and path planning of robotic manipulators. Prerequisite: EE 5550.

EE 5610. Information Theory. 3 Credits.
Introduction to probability concepts of information theory; entropy of probability models; theoretical derivations of channel capacity; coding methods and theorems, sampling theorems. Prerequisite: Graduate student or Instructor permission. Cross-listed with: CS 5610, CMPE 5610.

EE 5810. Digital Computer Design. 3 Credits.
To gain a solid understanding of digital computer operating mechanisms and reconfigurable computing, and advance into hands-on experiences to design and debug digital computer system and embedded system. Field programmable gate arrays (FPGAs) will be utilized as the development platform. Prerequisite: Electrical Engineering Graduate student, Computer Science Graduate student, or Instructor permission. Cross-listed with: CMPE 5810, CS 5810.

EE 5915. Advanced Circuit Applications. 3 Credits.
Analog and digital circuit applications. Topics may include analog to digital converters, operational amplifiers, optical isolators (linear and non-linear), comparators, voltage to frequency converters, analog switches, voltage references, precision dividers, analog multipliers, multiplexers, phase locked loops, power supply monitoring circuits, instrumentation amplifiers and pulse width modulators. Prerequisites: Electrical Engineering Graduate student or Instructor permission; Knowledge of material in EE 3110 Electronics I.

EE 5990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

EE 5993. Independent Study. 1-18 Credits.
A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

EE 6110. System Theory. 3 Credits.
Linear vector spaces. State equations and solution. Diagonalization and Jordan canonical form. Orthogonal and biorthogonal projections. Quadratic forms. Spectral resolution. Principal component analysis, singular value decomposition and Karhunen-Loeve transform. Compressive sensing. Prerequisites: MATH 3230 or MATH 3201; MATH 2544; EE 3150 or ME 2120.

EE 6120. Stochastic Processes. 3 Credits.
Probability theory, random variables and stochastic processes. Response of linear systems to random inputs. Applications in engineering. Prerequisites: Graduate student in CEMS or Instructor permission.

EE 6130. Convex Optimization. 3 Credits.
Provides advanced mathematical tools to recognize optimization problems from applications, presents rigorous theory of convex optimization with an emphasis on results that are helpful for implementation/computation/modeling, providing student with the experience and understanding necessary to use the tools in their own research work or applications. Prerequisites: Linear Algebra, multi-variable calculus.

EE 6391. Master's Thesis Research. 1-18 Credits.

EE 6392. Master's Project Research. 1-3 Credits.
Master's Project.

EE 6520. Nonlinear System Theory. 3 Credits.
Basic nonlinear methods including computational and geometrical techniques for analysis of nonlinear systems. Describing function methods and bifurcation and catastrophe theory. Sensitivity and stability considerations. Prerequisite: MATH 3230 or MATH 3201. Pre/Co-requisite: EE 6110 recommended.

EE 6530. Estimation Theory. 3 Credits.
Foundations of linear and nonlinear least squares estimation, smoothing and prediction, computational aspects, Kalman filtering, nonlinear filtering, parameter identification, and adaptive filtering. Applications to students' research. Pre/co-requisite: STAT 2510.

EE 6990. Special Topics. 1-18 Credits.
Advanced topics of current interest in Electrical Engineering. Prerequisite: Instructor permission.

EE 6991. Internship. 1-18 Credits.
On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

EE 6993. Independent Study. 1-18 Credits.
A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

EE 6995. Graduate Independent Research. 1-18 Credits.
Graduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

EE 7491. Doctoral Dissertation Research. 1-18 Credits.
Research for the Doctoral Dissertation.

EE 7990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

EE 7991. Internship. 1-18 Credits.
On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

EE 7995. Graduate Independent Research. 1-18 Credits.
Graduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.