ELECTRICAL ENGINEERING (ELEC)

ELEC 210 Intro Elec Circuits & Machines Units: 4.25
An introductory course for engineering students in disciplines other than electrical or computer engineering. The course begins with a review of the concepts of resistance, capacitance, and inductance. Circuit analysis techniques are then applied to characterize the behaviour of commonly used electrical energy conversion devices such as transformers, dc machines, and induction and synchronous machines.
COURSE DELETED 2018-2019
(Lec: 3, Lab: 0.75, Tut: 0.5)
Requirements: Prerequisite of APSC111 and APSC112 and APSC171 and APSC172 and APSC174 and registered in a BSCE or BASC Academic Program.
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 51
Engineering Design 0
Offering Faculty: Smith Engineering

ELEC 221 Electric Circuits Units: 4.25
This course introduces the circuit analysis techniques which are used in subsequent courses in electronics, power, and signals and systems. Circuits containing resistance, capacitance, inductance, and independent and dependent voltage and current sources will be studied. Emphasis is placed on DC, AC, and transient analysis techniques.
(Lec: 3, Lab: 0.75, Tut: 0.5)
Requirements: Prerequisites: APSC 112 or APSC 114, APSC 171, APSC 172, APSC 174 Corequisites: MTHE 235 or MTHE 237 or MTHE 225 or MTHE 232 Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 38
Engineering Design 13
Offering Faculty: Smith Engineering

ELEC 224 Continuous-Time Signals and Systems Units: 3.75
This is a first course on the basic concepts and applications of signals and systems analysis. Continuous time signals and systems are emphasized. Topics include: representations of continuous-time signals; linear time invariant systems; convolution, impulse response, step response; review of Laplace transforms with applications to circuit and system analysis; transfer function; frequency response and Bode plots; filtering concepts; Fourier series and Fourier transforms; signal spectra; AM modulation and demodulation; introduction to angle modulation.
(Lec: 3, Lab: 0.25, Tut: 0.5)
Requirements: Prerequisites: ELEC 221, MTHE 235 (MATH 235) or MTHE 237 (MATH 237) Corequisites: Exclusions: ELEC 323
Offering Term: W
CEAB Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 33
Engineering Design 0
Offering Faculty: Smith Engineering

ELEC 252 Electronics I Units: 4.25
This course is an introduction to semiconductor electronics for students in the Electrical Engineering program and related programs. Topics studied include: operational amplifiers; dc and small signal models for diodes, basic principles of bipolar transistors and field effect transistors, dc analysis of electronic circuits and practical applications of the devices to the design of power supplies, amplifiers and digital logic circuits.
(Lec: 3, Lab: 0.75, Tut: 0.5)
Requirements: Prerequisites: ELEC 221 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 15
Offering Faculty: Smith Engineering

ELEC 270 Discrete Mathematics with Computer Engineering App Units: 3.50
Introduction to the mathematics of representing and manipulating discrete objects. Topics include numbers, modular arithmetic, counting, relations and graph theory. Methods of proof and reasoning - such as induction and mathematical logic - will also be covered. Some applications to cryptosystems, hashing functions, job scheduling, and coding will be included.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: APSC 142 or APSC 143 or MNTC 313 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 0
Offering Faculty: Smith Engineering

ELEC 271 Digital Systems Units: 4.00
Boolean algebra applied to digital systems; logic gates; combinational logic design; electronic circuits for logic gates; arithmetic circuits; latches and flipflops, registers and counters; synchronous sequential logic and state machine design; implementation in programmable logic chips.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: APSC 171, APSC 172, APSC 174 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 27
Offering Faculty: Smith Engineering

ELEC 274 Computer Architecture Units: 4.00
Number and data representation. Logical structure of computers. Instruction set architecture. Instruction execution sequencing. Assembly-language programming. Input/output interfaces and programming. Processor datapath and control unit design. Semiconductor memory technology and memory hierarchy design.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: APSC 142 or APSC 143 or MNTC 313, ELEC 271 or MTHE 217 (MATH 217) or permission of instructor Corequisites: Exclusions: CISC 221
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 22
Offering Faculty: Smith Engineering

ELEC 278 Fundamentals Of Information Structures Units: 4.00
Fundamentals of Data Structures and Algorithms: arrays, linked lists, stacks, queues, deques, asymptotic notation, hash and scatter tables, recursion, trees and search trees, heaps and priority queues, sorting, and graphs. Advanced programming in the C language. Introduction to object oriented programming concepts in the context of data structures.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: APSC 142 or APSC 143 or MNTC 313 Corequisites: Exclusions: CISC 235, MREN 178
Offering Term: F
CEAB Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12
Offering Faculty: Smith Engineering

ELEC 279 Introduction to Object Oriented Programming Units: 4.00
Introduction to object-oriented design, architecture, and programming. Use of packages, class libraries, and interfaces. Encapsulation and representational abstraction. Inheritance. Polymorphic programming. Exception handling. Iterators. Introduction to a class design notation. Applications in various areas.
(Lec: 3, Lab: 1, Tut: 0)
Requirements: Prerequisites: APSC 142 or APSC 143 or MNTC 313, ELEC 278 Corequisites: Exclusions: CISC 124, CMPE 212
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 22
Offering Faculty: Smith Engineering

ELEC 280 Fundamentals of Electromagnetics Units: 3.75
A study of the fundamental aspects of electromagnetic fields. The following topics are covered: the Maxwell's equations and the 3-dimensional wave equation for transmission lines; vector analysis, including orthogonal coordinate systems, and the calculus of field quantities; electrostatic fields including the concepts of electric potential, capacitance, and current and current density; magnetostatic fields including inductance; time-varying fields and the complete form of Maxwell's equations; basic transmission line phenomena including steady-state sinusoidal behaviour and standing waves, transient performance and impedance matching.
(Lec: 3, Lab: 0.25, Tut: 0.5)
Requirements: Prerequisites: APSC 112 or APSC 114, APSC 171, APSC 172, APSC 174 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 27
Complementary Studies 0
Engineering Science 18
Engineering Design 0
Offering Faculty: Smith Engineering

ELEC 290 Electrical and Computer Engineering Design and Practice Units: 5.00
This course encompasses team-based design to solve complex open-ended problems. Instruction is provided on problem definition, creation of ideas, and decision making that considers technical, economic, societal, and environmental factors. Attention is given to safety considerations, technical codes and regulations, and engineering ethics. Effective skills for oral and written communication are also emphasized. These aspects are applied in design project activity related to electrical and computer engineering.
K5 (Lec: Yes, Lab: Yes, Tut: Yes)
Requirements: Prerequisites: APSC 100 or APSC 103; APSC 199 or have passed the English Proficiency Test Corequisites: Exclusions: APSC 200, APSC 293
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Science 0
Engineering Design 42
Offering Faculty: Smith Engineering

ELEC 292 Introduction to Data Science Units: 3.00
Fundamentals of data science: data capture, organization and maintenance, processing, and visualization. Implementation of data processing methods using Python. Application of the methods to design and implement a solution to a project-based data science problem.
K3 (Lec: Yes, Lab: Yes, Tut: No)
Requirements: Prerequisites: ELEC 278 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 18
Offering Faculty: Smith Engineering

ELEC 299 Mechatronics Project Units: 1.50
A team design project based around an autonomous, programmable, robotic vehicle. Students explore different sensors and software strategies for vehicle control and navigation, in addition to wiring up sensor and motor circuits. The design goal is to configure and program a vehicle to accomplish a specified task. A final project report that documents the experimentation, design, and testing must be produced.
COURSE DELETED 2023-2024
K1.5(Lec: No, Lab: Yes, Tut: No)
Requirements: Prerequisites: ELEC 221, ELEC 271
Corequisites: ELEC 252, ELEC 280 Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 18
Offering Faculty: Smith Engineering

ELEC 310 Introductory Analog Electronic and Digital Circuits Units: 4.50
This is an introductory course on the design of analog electronic and digital logic circuits, using commonly available devices and integrated circuits. The properties of linear circuits, with particular reference to the applications of feedback, are discussed; operational amplifiers are introduced as the fundamental building block for the design of linear filters and amplifiers. Fundamentals of digital circuits including Boolean algebra, logic gates, combinational logic, sequential logic concepts and implementation are presented. Data acquisition and conversion is introduced, and the issues of noise and electromagnetic compatibility are discussed. Laboratory work is linked with lectures and provides practical experience of the subjects covered in lectures.
COURSE DELETED 2018-2019
(Lec: 3, Lab: 1, Tut: 0.5)
Requirements: Prerequisites: ELEC 210 or ELEC 221
Corequisites: Exclusions: ENPH 334 (PHYS 334)
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 27
Engineering Design 27
Offering Faculty: Smith Engineering

ELEC 323 Continuous-Time Signals and Systems Units: 3.75
This is a first course on the basic concepts and applications of signals and systems analysis. Continuous time signals and systems are emphasized. Topics include: representations of continuous-time signals; linear time invariant systems; convolution, impulse response, step response; review of Laplace transforms with applications to circuit and system analysis; transfer function; frequency response and Bode plots; filtering concepts; Fourier series and Fourier transforms; signal spectra; AM modulation and demodulation; introduction to angle modulation.
COURSE DELETED 2019-2020
(Lec: 3, Lab: 0.25, Tut: 0.5)
Requirements: Prerequisite of ELEC221 and (MTHE235 or MTHE237) and registered in a BSCE or BASC Academic Program.
Offering Term: F
CEAB Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 33
Engineering Design 0
Offering Faculty: Smith Engineering

ELEC 324 Discrete-Time Signals and Systems Units: 4.00
This second course on signals and systems studies basic concepts and techniques for analysis and modeling of discrete-time signals and systems. The topics of this course are: sampling, reconstruction, and digitization; representations and properties of discrete-time signals and systems; linear time-invariant (LTI) systems; difference equations; discrete Fourier series; discrete-time Fourier transform; discrete Fourier transform; z-transform; analysis of LTI systems; filtering and spectral analysis. Computational realizations of the analysis tools and their applications are explored in the laboratory.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: ELEC 323 or ELEC 224
Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 0
Offering Faculty: Smith Engineering

ELEC 326 Probability & Random Processes Units: 3.50
This course provides an introduction to probabilistic models and methods for addressing uncertainty and variability in engineering applications. Topics include sample spaces and events, axioms of probability, conditional probability, independence, discrete and continuous random variables, probability density and cumulative distribution functions, functions of random variables, and random processes.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: APSC 171 Corequisites: Exclusions: MTHE 351 (STAT 351)
Offering Term: F
CEAB Units:
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 0
Offering Faculty: Smith Engineering

ELEC 333 Electric Machines Units: 4.25
An introduction to the basic principles, operating characteristics, and design of electric machines. Topics to be studied include: three-phase circuits; magnetic circuits; transformers; steady state behaviours of dc generators and motors; rotating magnetic fields; steady state operation of induction machines and synchronous machines; introduction to fractional horsepower machines; speed control of electric motors.
(Lec: 3, Lab: 0.75, Tut: 0.5)
Requirements: Prerequisites: ELEC 221 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 13
Complementary Studies 0
Engineering Science 25
Engineering Design 13
Offering Faculty: Smith Engineering

ELEC 344 Sensors and Actuators Units: 3.75
This course provides an introduction to sensing and actuation in mechatronic systems. The topics include physical principles for the measurement and sensing of displacement, motion, force, torque, pressure, flow, humidity, radiation (visible and IR) and temperature using analog and digital transducers; actuating principles using continuous drive actuators, stepper motors, optical encoders and servo motors; and methods for signal collection, conditioning and analysis.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0.75, Tut: 0)
Requirements: Prerequisites: ELEC 221, ELEC 271 and ELEC 252 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 27
Engineering Design 18
Offering Faculty: Smith Engineering

ELEC 345 Sensor Fabrication Technologies Units: 3.25
This course introduces sensor fabrication technologies. The topics include various types of sensors' design, fabrication processes, and applications. Students will learn standard micro and nano fabrication and cleanroom processing such as lithography, material deposition methods and systems, wet and dry etching, encapsulation, characterization methods and systems, etc. The effect of design parameters and fabrication processes on the performance of sensors will be discussed. The lab component of the course includes demonstration of the fabrication process in the cleanroom and operation of some sensors.
(Lec: 3, Lab: 0.25, Tut: 0)
Requirements: Prerequisites: ELEC 221, ELEC 271, ELEC 252 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 27
Engineering Design 12
Offering Faculty: Smith Engineering

ELEC 353 Electronics II Units: 4.25
Transistor-level modeling and design of analog and digital electronic circuits. Differential amplifiers, Gilbert Cell multipliers, multi-stage amplifiers, amplifier frequency response, negative feedback amplifiers, LC-tank and crystal oscillators, two-port networks. Advanced concepts in logic design. Students learn the basics of computer aided design (CAD) of integrated circuits including schematic simulation, layout, design rules, layout versus schematic verification and extracted circuit simulation. Laboratory work is design-oriented and students are introduced to advanced test and measurement techniques using vector network analyzers.
(Lec: 3, Lab: 0.75, Tut: 0.5)
Requirements: Prerequisites: ELEC 252 Corequisites: ELEC 224 or MREN 223 or MTHE 335 or ENPH 316 Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 25
Offering Faculty: Smith Engineering

ELEC 371 Microprocessor Interfacing and Embedded Systems Units: 4.00
Microprocessor bus organization and memory interfaces; parallel input/output interface design; assembly-language and high-level-language programming; interrupts and exceptions; timers; embedded systems organization and design considerations; integration in microcontrollers and programmable logic chips; interfacing with sensors and actuators; embedded system case studies.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: ELEC 271, CISC 231 or ELEC 274 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 12
Offering Faculty: Smith Engineering

ELEC 372 Numerical Methods and Optimization Units: 3.50
Number representation in digital computers, error analysis, and iterative calculations. Methods for finding roots of equations, solving systems of linear algebraic equations, single- and multi-variable optimization, least-squares analysis, curve fitting, differentiation and integration, and solving ordinary differential equations. Implementation of numerical algorithms in software.
(Lec: 3, Lab: 0.5, Tut: 0)
Requirements: Prerequisites: APSC 142 or APSC 143 or MNTC 313, APSC 174, MTHE 235 or MTHE 237 or MTHE 225 Corequisites: Exclusions: MTHE 272, CIVL 222, ELEC 273
Offering Term: W
CEAB Units:
Mathematics 21
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 0
Offering Faculty: Smith Engineering

ELEC 373 Computer Networks Units: 3.50
Network architecture with physical, data link, network, and transport layers for frame transmission and packet switching, standards such as Ethernet and 802.11 for wired and wireless networks, protocols such as TCP/IP, internetworking, routing, and socket programming.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: ELEC 326 or MTHE 351 (STAT 351), ELEC 274 or CISC 221 Corequisites: Exclusions: CISC 435
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 31
Engineering Design 11
Offering Faculty: Smith Engineering

ELEC 374 Digital Systems Engineering Units: 4.25
High-performance logic design for arithmetic circuits; memory system designs based on static and dynamic RAMs; computer bus protocols and standard I/O interfaces; mass storage devices; hardware description languages (VHDL, Verilog); fault testing, design for testability, built-in self-test, memory testing, and boundary-scan architectures; asynchronous sequential circuit design; introduction to GPU architectures and GPU computing. The course is supplemented by a CPU design project that allows students to become proficient with Field Programmable Gate Array (FPGA) devices and associated CAD tools, as well as with GPU computing through nVidia CUDA or OpenCL languages.
(Lec: 3, Lab: 1, Tut: 0.25)
Requirements: Prerequisites: ELEC 252, ELEC 271, ELEC 274 or permission of the instructor Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 28
Engineering Design 23
Offering Faculty: Smith Engineering

ELEC 376 Software Development Methodology Units: 3.50
Methodology for object-oriented software design and implementation, modeling notations/languages, template libraries, considerations for graphical user interfaces, techniques and tools for managing software projects in teams, and documentation for requirements analysis and system design.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: ELEC 278 Corequisites: Exclusions: CMPE 320
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21
Offering Faculty: Smith Engineering

ELEC 377 Operating Systems Units: 4.00
Operating systems for conventional shared memory computers. System services and system calls, concurrent processes and scheduling, synchronization and communication, deadlock. File systems and protection, memory management and virtual memory, device management and drivers. Unix operating system. Real-time and distributed systems. Security.
(Lec: 3, Lab: 1, Tut: 0)
Requirements: Prerequisites: ELEC 274 or CISC 221 and ELEC 278 or CISC 235 Corequisites: Exclusions: CMPE 324 (CISC 324)
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 22
Offering Faculty: Smith Engineering

ELEC 379 Algorithms with Engineering Applications Units: 4.00
Algorithm design and analysis; techniques based on divide and conquer, branch and bound, dynamic programming, and the greedy approach; computer engineering applications such as circuit partitioning and logic circuit technology mapping; computational complexity and NP-completeness.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: ELEC 278, ELEC 270 or any discrete mathematics course Corequisites: Exclusions: CMPE 365
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 24
Offering Faculty: Smith Engineering

ELEC 381 Applications of Electromagnetics Units: 3.75
Partial differential equation solutions to Maxwell's Equations; Introduction to the Smith chart; uniform plane waves; reflection of plane waves; normal and oblique incidence; analysis and applications of rectangular waveguides; resonant cavities; optical fibres; introduction to antennas; aperture antennas.
(Lec: 3, Lab: 0.25, Tut: 0.5)
Requirements: Prerequisites: ELEC 280 or ENPH 231 (PHYS 231) or PHYS 235 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 21
Offering Faculty: Smith Engineering

ELEC 390 Principles of Design and Development Units: 3.50
The goal of this course is to prepare students for definition, design, management, and development of engineering projects and products. Students will learn about problem definition and impact analysis from an economic standpoint as well as other perspectives. Different design principles, management techniques, and development methodologies will be described. Culture and communication in teams will be discussed, followed by important concepts in ethics and intellectual property. Specific software and tools that are available for facilitating design/development activity will be introduced and utilized throughout the term. Students will apply concepts and explore issues through projects and laboratory activity.
K3.5(Lec: Yes, Lab: Yes, Tut: Yes)
Requirements: Prerequisites: Successful completion of Fall term 3rd year studies in either the Electrical Engineering program, or the Computer Engineering program. Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 15
Engineering Science 0
Engineering Design 27
Offering Faculty: Smith Engineering

ELEC 408 Biomedical Signal and Image Processing Units: 3.00
This is an introductory course in biomedical signal and image processing.
Topics include: biopotential generation and detection; the biomedical signals
with a focus on the electrocardiogram and electroencephalogram; recording artifacts and signal compression; major medical imaging modalities; 2D and 3D image formation; image processing techniques including spatial and
frequency-domain filtering, feature extraction and convolutional neural networks; applications in diagnostics, therapeutics, and interventions.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ELEC 224 or MREN 223 or permission of the instructor Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 9
Complementary Studies 0
Engineering Science 18
Engineering Design 9
Offering Faculty: Smith Engineering

ELEC 409 Bioinformatic Analytics Units: 3.00
The course surveys: microarray data analysis methods; pattern discovery, clustering and classification methods; applications to prediction of clinical outcome and treatment response; coding region detection and protein family prediction. At the end of this course, students should be able to appreciate some approaches related to individualizing medical treatment, as well as to apply some of the methods, such as alternatives to PCA, to more traditional engineering problems.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: APSC 174, ELEC 224 or MREN 223, ELEC 326 or ENPH 252 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 9
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 9
Offering Faculty: Smith Engineering

ELEC 421 Digital Signal Processing: Filters and System Design Units: 4.00
Sampling theorem, filter realization structures, quantization errors and finite word length effects, digital signal processor programming, finite and infinite impulse response filter design techniques, discrete and fast Fourier transform.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: ELEC 324 or MTHE 335 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 24
Offering Faculty: Smith Engineering

ELEC 422 Digital Signal Processing: Random Models and Applications Units: 3.50
Recent DSP topics including: bandpass sampling, oversampling A/D conversion, quantization noise modelling, multi-rate signal processing, filterbanks, quadrature mirror filters, applications to communications systems, speech and image compression; processing of discrete-time random signals.
NOT OFFERED 2022-2023
(Lec: 3, Lab: 0.5, Tut: 0)
Requirements: Prerequisites: ELEC 324 or MTHE 335; ELEC 326, or MTHE 351. Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 27
Offering Faculty: Smith Engineering

ELEC 425 Machine Learning and Deep Learning Units: 3.50
Supervised and unsupervised machine learning methods for regression, classification, clustering, and time series modeling. Methods of fitting models. The problem of overfitting and techniques for addressing it. Deep learning and neural network models. Processes for how to refine/ implement/ test applications of machine/deep learning algorithms.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0.25, Tut: 0.25)
Requirements: Prerequisites: ELEC 278 or CISC 235 or MREN 178, ELEC 326 or permission of the instructor Corequisites: Exclusions: CMPE 452
Offering Term: F
CEAB Units:
Mathematics 11
Natural Sciences 0
Complementary Studies 0
Engineering Science 20
Engineering Design 11
Offering Faculty: Smith Engineering

ELEC 431 Power Electronics Units: 3.25
This course introduces the basic concepts of power electronics, which include power semiconductor devices and switching power converters. Emphasis is placed on the analysis and design of various power electronics circuits. Their industrial application, such as in telecommunications and computing, will also be discussed. More specifically, the course will cover the characteristics of switching devices, especially that of MOSFET. The course will also cover the operation of various switching converters such as phase controlled ACto- DC converters, AC voltage controllers, DC-to-DC switching converters, DC-to-AC inverters and switching power supplies. The requirements and configurations of power systems for telecommunications will be introduced. The techniques to analyze and design these power systems using available components will also be discussed. Computer simulation will be used to analyze the detailed operation of switching converters.
(Lec: 3, Lab: 0.25, Tut: 0)
Requirements: Prerequisites: ELEC 252 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 24
Offering Faculty: Smith Engineering

ELEC 433 Energy and Power Systems Units: 3.50
Energy resources and electric power generation with particular emphasis on renewable energy systems such as solar, wind, and biomass; review of balanced and unbalanced 3-phase systems; review of per-unit systems; real and reactive power, sequence networks and unsymmetrical analysis; transmission line parameters; basic system models; steady state performance; network calculations; power flow solutions; symmetrical components; fault studies; short circuit analysis; economic dispatch; introduction to power system stability, operating strategies and control; modern power systems and power converters; DC/AC and AC/DC conversion; and introduction to DC transmission.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: ELEC 333 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 18
Offering Faculty: Smith Engineering

ELEC 436 Electric Machines and Control Units: 3.00
Review of basic electric machines. Salient pole synchronous machines. Transient and dynamic behaviour of electric machines. Characteristics and applications of special motors such as servo motors, stepper motors, PMmotors, brushless dc motors, switched reluctance motors and linear motors. Solid state speed and torque control of motors.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ELEC 333 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 18
Offering Faculty: Smith Engineering

ELEC 443 Linear Control Systems Units: 4.00
Introduction to linear systems and feedback control. Topics include introduction to automatic control, overview of Laplace transformation, linear models of dynamic systems, time-domain specifications of first and second order systems, stability analysis using Routh-Hurwitz criterion, steady-state error and disturbance rejection, PID control, stability analysis and linear controller design using root locus method, Nyquist criterion, and Bode plots, and introduction to state-space analysis. These methods are applied and tested using software such as MATLAB/Simulink, and laboratory experiments.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: ELEC 224 or MTHE 335 or MREN 223 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 33
Offering Faculty: Smith Engineering

ELEC 444 Modeling and Computer Control of Mechatronic Systems Units: 3.25
This course provides an introduction to modeling and analysis of the dynamics of mechatronic processes and computer control of such systems. Topics include modeling and simulation of mechanical, electrical, thermal, and fluid systems, sampled-data systems and equivalent discrete system, overview of
Z-transform, dynamic response of second-order discrete systems,
stability analysis and design of linear discrete-time control systems
using root locus and frequency response methods. The modeling
and controller design methods are implemented and tested using MATLAB/Simulink and laboratory experiments.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0.25, Tut: 0)
Requirements: Prerequisites: ELEC 324 or MREN 223, ELEC 344 or ELEC 345 or MREN 318, ELEC 443 or MECH 350 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 29
Engineering Design 10
Offering Faculty: Smith Engineering

ELEC 448 Introduction To Robotics Units: 3.50
Robotics is an interdisciplinary subject concerning areas of mechanics, electronics, information theory, control systems and automation. This course provides an introduction to robotics and covers fundamental aspects of modeling and control of robot manipulators. Topics include history and application of robotics in industry, rigid body kinematics, manipulator forward, inverse and differential kinematics, workspace, singularity, redundancy, manipulator dynamics, trajectory generation, actuators, sensors, and manipulator position and contact force control strategies. Applications studied using MATLAB/Simulink software simulation and laboratory experiments.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0.5, Tut: 0)
Requirements: Prerequisites: Corequisites: ELEC 443 or MTHE 332 or MECH 350 Exclusions: MECH 456, MREN 348
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 16
Engineering Design 26
Offering Faculty: Smith Engineering

ELEC 451 Digital Integrated Circuit Engineering Units: 3.25
Review of MOS transistor structure and operation; overview of wafer processing and device implementation, layout and design rules. CMOS gate design; static
and dynamic logic; modelling of transients and delays. Clocked circuits; interconnect effects, and I/O. Memory and programmable logic arrays.
Technology scaling effects; design styles and flow.
(Lec: 3, Lab: 0.25, Tut: 0)
Requirements: Prerequisites: ELEC 252 , ELEC 271 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 18
Offering Faculty: Smith Engineering

ELEC 454 Analog Electronics Units: 3.25
Topics include; an introduction to noise and distortion in electronic circuits, analysis and design of biasing circuits, references, ADCs and DACs, power amps, mixers, modulators and PLLs along with a short introduction to analog filter design.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0.25)
Requirements: Prerequisites: ELEC 224 or MREN 223 or MTHE 335, ELEC 353 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 20
Engineering Design 19
Offering Faculty: Smith Engineering

ELEC 457 Integrated Circuits and System Application Units: 3.50
In the first part of this course modern microelectronic circuits are covered and in the second part these circuits are used in new and emerging applications. Topics include: active and passive filtering circuits, phase locked loops, frequency synthesizers, RF modulators, clock and data recovery circuits, RF energy harvesting, ultra low-power circuits, biotelemetry systems, biological sensors, neurostimulator circuits, introduction to radiometry and radar imaging.
(Lec: 3, Lab: 0.5, Tut: 0)
Requirements: Prerequisites: ELEC 353, ELEC 224 or MTHE 335 or MREN 223 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21
Offering Faculty: Smith Engineering

ELEC 461 Digital Communications Units: 3.50
Representation of signals and noise, Gaussian processes, correlation functions and power spectra. Linear systems and random processes. Performance analysis and design of coherent and noncoherent communication systems, phase-shift-keying, frequency-shift,-keying, and M-ary communication systems. Optimum receivers and signal space concepts. Information and its measure, source encoding, channel capacity and error correcting coding.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: ELEC 324 or MTHE 335 or MREN 223, ELEC 326 or MTHE 351, or permission of instructor Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21
Offering Faculty: Smith Engineering

ELEC 464 Wireless Communications Units: 3.00
Fundamental principles and practice of current wireless communications systems and technologies. Historical context, the wireless channel including path loss, shadowing, fading, and system modes in use. Capacity limitations on transmission rate, transmission of data by signaling over wireless channels via digital modulation, optimum receivers, countermeasures to fading and interference via diversity and equalization, multiple user systems including multiple access FDMA, TDMA, CDMA, FDMA/TDMA, uplink and downlink; capacity and power control, design of cellular networks. Selected standards and emerging trends are also surveyed.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ELEC 324 or MREN 223 and ELEC 326 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 18
Offering Faculty: Smith Engineering

ELEC 470 Computer System Architecture Units: 3.50
This course covers advanced topics in computer architecture with a quantitative perspective. Topics include: instruction set design; memory hierarchy design; instruction-level parallelism (ILP), pipelining, superscalar processors, hardware multithreading; thread-level parallelism (TLP), multiprocessors, cache coherency; clusters; introduction to shared-memory and message-passing parallel programming; data-level parallelism (DLP), GPU architectures.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: ELEC 371, ELEC 274 or CISC 221 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 31
Offering Faculty: Smith Engineering

ELEC 472 Artificial Intelligence Units: 3.50
Fundamental concepts and applications of intelligent and interactive system design and implementation. Topics include: problem formulation and experiment design, search techniques and complexity, decision making and reasoning, data acquisition, data pre-processing (de-noising, missing data, source separation, feature extraction, feature selection, dimensionality reduction), supervised learning, unsupervised learning, and swarm intelligence.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0.5, Tut: 0)
Requirements: Prerequisites: ELEC 278 or MREN 178, ELEC 326 or permission of the instructor Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 31
Engineering Design 11
Offering Faculty: Smith Engineering

ELEC 473 Cryptography and Network Security Units: 3.00
Cryptography topics include: block ciphers, advanced encryption standard, public key encryption, hash functions, message authentication codes, digital signatures, key management and distribution, and public-key infrastructure. Network security topics include: user authentication, network access control, Kerberos protocol, transport layer security (TLS), IP security (IPSec), electronic mail security, and wireless network security.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ELEC 373 or CISC 435, ELEC 270 or CISC 102 or permission of instructor Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 10
Offering Faculty: Smith Engineering

ELEC 474 Machine Vision Units: 3.50
Image acquisition and representation, histogramming, spatial- and frequency-domain filtering, edge detection, motion segmentation, color indexing, blob detection, interest operators, feature extraction, camera models and calibration, epipolar geometry and stereovision. The lab and assignments will emphasize practical examples of machine vision techniques to industrial and mechatronic applications. NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: ELEC 278 or CISC 235 or MREN 178 Corequisites: Exclusions: CMPE 457
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 31
Engineering Design 11
Offering Faculty: Smith Engineering

ELEC 475 Computer Vision with Deep Learning Units: 3.50
Deep learning methods are highly effective at solving many problems in computer vision. This course serves as an introduction to these two areas and covers both the theoretical and practical aspects required to build effective deep learning-based computer vision applications. Topics include classification, convolutional neural networks, object detection, encoder-decoders, segmentation, keypoint and pose estimation, generative adversarial networks, and transformers. Labs and assignments will emphasize practical implementations of deep learning systems applied to computer vision problems.
(Lec: 3, Lab: 0.5, Tut: 0)
Requirements: Prerequisites: ELEC 278 or CISC 235 or MREN 178 Corequisites: Exclusions: CISC 473
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 31
Engineering Design 11
Offering Faculty: Smith Engineering

ELEC 477 Distributed Systems Units: 3.00
Client/server architectures, multicasting, real-time distributed protocols, naming and name services, fault tolerance, security, and embedded-systems considerations.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ELEC 373, ELEC 377 Corequisites: Exclusions: CMPE 434
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12
Offering Faculty: Smith Engineering

ELEC 481 Applications of Photonics Units: 3.00
Overview of light-matter interaction, design of optical waveguides, modeling of photonic devices, light propagation in periodic and subwavelength structures. Applications of photonics in LIDAR for autonomous vehicles, design of optical phased array, design of holography, medical imaging and sensing, optoelectronics and renewable energy.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ELEC 381 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 18
Offering Faculty: Smith Engineering

ELEC 483 Microwave and RF Circuits and Systems Units: 4.25
This course introduces the analysis and design of microwave components and systems. Topics include: modeling of high frequency circuits; transmission lines; scattering parameters; impedance matching; passive microwave components; amplifiers, mixers and oscillators; noise in receivers; elemental antennas and simple and phased arrays; communication links - microwave land, cellular and satellite systems; performance and link budget analysis. The laboratory work is design oriented and implements the lecture material.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0.75, Tut: 0.5)
Requirements: Prerequisites: ELEC 353, ELEC 381 or ENPH 431 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 25
Offering Faculty: Smith Engineering

ELEC 486 Fiber Optic Communication Units: 3.75
This course introduces fundamental principles and applications of fiber optic communication systems. Topics include Fabry-Perot and distributed feedback semiconductor lasers, planar dielectric waveguides, propagation characteristics of single-mode optical fibers, p-i-n and avalanche photodiodes, and digital receiver performance. Device technology and system design applications are considered.
(Lec: 3, Lab: 0.25, Tut: 0.5)
Requirements: Prerequisites: ELEC 381 or ENPH 431 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 24
Offering Faculty: Smith Engineering

ELEC 490 Electrical Engineering Project Units: 7.00
Students work in groups of three on the design and implementation of electrical engineering projects, with the advice of faculty members. This course is intended to give students an opportunity to practice independent design and analysis. Each group is required to prepare an initial engineering proposal, regular progress reports, and a final report together with a formal seminar on the project and its results.
K7(Lec: Yes, Lab: Yes, Tut: Yes)
Requirements: Prerequisites: ELEC 324, ELEC 326, ELEC 353, ELEC 371, ELEC 372, ELEC 381, ELEC 390, or permission of the department Corequisites: Exclusions:
Offering Term: FW
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 21
Engineering Science 0
Engineering Design 63
Offering Faculty: Smith Engineering

ELEC 491 Advanced ECE Thesis I Units: 6.00
Students will be assigned individual Research Topics. Students must work under the supervision of a faculty member. Grade will be based on the progress in arriving at a solution to the assigned problem.
COURSE DELETED 2021-2022
(Lec: 0, Lab: 6, Tut: 0)
Requirements: Permission of Thesis Supervisor
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 54
Engineering Design 18
Offering Faculty: Smith Engineering

ELEC 492 Advanced ECE Thesis II Units: 6.00
The students continue working on their assigned problems in ELEC 491 under the supervision of the same faculty member. Upon completion of their thesis, students must give oral and written presentations. Grades will be based on the quality of the analysis of the problem, the proposed solution, and written and oral presentations. Demonstration of effective written and oral communications skills is required.
COURSE DELETED 2021-2022
(Lec: 0, Lab: 6, Tut: 0)
Requirements: Prerequisites: ELEC 491 Corequisites: Exclusions:
Offering Term: FW
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 54
Engineering Design 18
Offering Faculty: Smith Engineering

ELEC 497 Research Project Units: 3.50
The student works on a research project under the supervision of a faculty member. A research problem is formulated and the problem is contextualized within the discipline. The student does a current literature review, and explores in detail a solution to the research problem. Subject to Department approval.
K3.5(Lec: No, Lab: No, Tut: No)
Requirements: Prerequisites: Corequisites: Exclusions: ELEC 491
Offering Term: FWS
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21
Offering Faculty: Smith Engineering

ELEC 498 Computer Engineering Project Units: 7.00
Students work in groups of three on the design and implementation of computer engineering projects, with the advice of faculty members. This course is intended to give students an opportunity to practice independent design and analysis. Each group is required to prepare an initial engineering proposal, regular progress reports, and a final report together with a formal seminar on the project and its results.
K7(Lec: Yes, Lab: Yes, Tut: Yes)
Requirements: Prerequisites: ELEC 326, ELEC 371, ELEC 374, ELEC 377, ELEC 390, CMPE 223 (CISC 223) or CMPE 320 (CISC 320), or permission of the department Corequisites: Exclusions:
Offering Term: FW
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 21
Engineering Science 0
Engineering Design 63
Offering Faculty: Smith Engineering

ELEC 801 Linear-System Analysis Units: 3.00
Offering Faculty: Smith Engineering

ELEC 821 Analog Filter Design Units: 3.00
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 822 Linear Active Network Analysis Units: 3.00
Offering Faculty: Smith Engineering

ELEC 823 Signal Processing Units: 3.00
This course covers basic topics in statistical signal processing and machine learning with applications in speech, communication, and biomedical signal processing. The student is assumed to be familiar with digital signal processing rudiments such as discrete Fourier transforms and design and analysis of digital filters. Topics covered include: spectral modeling, linear prediction, optimal filtering, adaptive filters, Bayesian inference, linear models, support vector machines, neural networks, and hidden Markov models.
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 825 Machine Learning and Deep Learning Units: 3.00
Basic machine learning concepts in supervised and unsupervised learning; discriminative and generative models; backpropagation, FFN, CNN, RNN, autoencoders; regularization technologies; attention-based models, Transformer, Capsule Networks; pretraining and selfsupervised models; Generative Adversarial Networks (GANs), variational autoencoders; applications.
PREREQUISITE: ELEC 326 or equivalent, or permission of the instructor.
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 827 Multimedia Signal Processing Units: 3.00
Study of multimedia signal processing for network mediated human-human communication and human machine interaction (HMI). Topics covered include: overview of multimedia applications and processing functions; speech production; human auditory and speech perception; image formation; human visual perception; perceptual quality and user experience modeling; speech and image analysis and synthesis methods; lossless and lossy compression techniques; coding for communication and storage; sensing modalities for HMI; machine learning algorithms for information extraction and understanding.
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 829 Optimization for Machine Learning Units: 3.00
This course provides students with an in-depth understanding of optimization methods specifically tailored for machine learning. It covers the foundations of convex analysis and widely used optimization algorithms in machine learning such as gradient descent, subgradient, and projected gradient methods. Proximal methods and regularized optimization will be covered for handling optimization problems with non-smooth objectives or constraints. Stochastic gradient methods, including stochastic (sub)gradient descent and variance-reduced stochastic gradient, will be discussed for handling large datasets. The course will conclude by exploring non-convex optimization using coordinate descent, Newton¿s and Quasi-Newton Methods, and adaptive methods. The course emphasizes both the theoretical foundations and practical applications of these optimization techniques within the context of machine learning algorithms. By the end of the course, students will be well-versed in advanced optimization methods and equipped to apply them effectively in machine learning scenarios, enhancing model performance, convergence rates, and robustness. (3.0 credit units).
PREREQUISITES: Working knowledge of linear algebra and probability. Prior exposure to optimization is a plus but not necessary.
Offering Faculty: Smith Engineering

ELEC 830 Emerging Technologies in Power Grid Units: 3.00
Renewable energy generation; wind and Photovoltaic energy conversion; energy storage; distributed energy generation; hybrid systems; Power electronics interfaces and control. Grid- connected distributed sources. Stand-alone operation of distributed sources and micro-grid systems. System protection. Economical dispatch. Centralized and decentralized control. Smart grid.
Offering Faculty: Smith Engineering

ELEC 831 Power Electronics Units: 3.00
Fundamentals of loss-less switching techniques: zero-voltage switching, zero-current switching. Resonant converters: series, parallel and series-parallel topologies; Soft-switching converters: natural and auxiliary commutation converter topologies; Control techniques: variable frequency, phase-shift and hybrid control. Applications to single-phase three-phase and multi-level converters. Special emphasis will be placed on the design techniques using practical examples. Three term-hours, lectures.P. Jain.
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 832 Switching Power Converters Units: 3.00
This course covers the modeling and control techniques for switching power converters. Small signal models and large signal models will be presented. Peak current mode control and average current mode control for switching power converters will be investigated. System stability issues when several power supplies are connected together are investigated and solutions are presented and analyzed. Digital control techniques, using FPGA or DSP, will be investigated and analyzed. Conventional fuzzy logic control and improved version of fuzzy logic control will be analyzed in detail. Sliding mode control and sliding mode like control will be analyzed. Digital control techniques for AC-DC converter with power factor correction will be analyzed. It is expected the students will do a project based one or more of the above mentioned techniques. Three term-hours, lectures, fall. Y.F. Liu.
Offering Faculty: Faculty of Arts and Science

ELEC 834 Micro-Grid Technology Units: 3.00
This course covers various power electronics technologies for micro-grids, nano-grids and energy harvesting systems. In this course various types of micro-grids will be covered (e.g., AC microgrids, hybrid micro-grids, and DC micro-grids), along with their respective architectures and control systems. PREREQUISITES: ELEC 431 and ELEC 443, or equivalent, or permission of the instructor.
Offering Faculty: Smith Engineering

ELEC 835 Nonlinear Control for Power Electronics Units: 3.00
This course provides an overview of advanced nonlinear control and its application in power electronics. It covers mathematical background and major topics in this area. Students will be introduced to the rigorous mathematical background for nonlinear systems particularly differential geometry. Then, the design of nonlinear control systems will be covered for power electronics applications. PREREQUISITES: ELEC 431 (Power Electronics) or equivalent or permission of the instructor, and ELEC 443 (Linear Control Systems) or equivalent.
Offering Faculty: Smith Engineering

ELEC 837 High Power Electronics Units: 3.00
Introduction. Power semiconductor devices. Line- and force-commutated converters. High power ac/dc and dc/ac converter structures and switching techniques. Principles of HVDC and HVAC systems. Large and small scale stabilities, sub-synchronous resonances, inter-area oscillations, voltage sags, and harmonic instability. Voltage, power angle, and impedance control, phase balancing, and power factor correction by means of solid-state power converters. Flexible AC Transmission Systems (FACTS). Three term hours; lectures, Winter. A. Bakhshai
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 841 Nonlinear Sys. Identification Units: 3.00
Analytical methods for nonlinear systems; nonlinear difference equation models: functional expansions and Volterra, Wiener and Fourier-Hermite kernels; kernel estimation techniques; identification of cascades of linear and static nonlinear systems; use of Volterra series to find region of stability of nonlinear differential equations; applications to pattern recognition, communications, physiological systems, and non-destructive testing. Three term-hours; lectures, Fall. M.J. Korenberg
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 843 Control Of Discrete-Event Sys. Units: 3.00
Study of discrete-event processes that require control to induce desirable behaviour. Topics include: basic automata and language theory; modeling of processes using automata (finite-state machines, directed graphs); centralized and decentralized problems; nonblocking supervisors; partial observation; and computational complexity. Connections with manufacturing systems and communication protocols are emphasized. Three term-hours; lectures, Fall. K. Rudie
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 845 Vehicle Control and Navigation Units: 3.00
The objective of this course is to introduce graduate-level engineering students to the fundamentals of autonomous vehicles engineering. The course focuses on those tasks usually carried out by autonomy engineers, including sensor selection, applied control (e.g., trajectory and path following) and navigation techniques for autonomous vehicles that operate in real environments (e.g., mining, construction, warehouses, roadways, etc.). Although the focus in this course is on ground vehicles, the presented methods are also applicable more broadly. The audience is engineers from all relevant engineering and applied science disciplines who have an interest in mobile robotics, applied control and estimation, and robotic vehicle applications. EXCLUSION: MINE-855
Requirements: ELEC422_MECH 350 or equivalent
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 846 Intro. To Optimal Control Units: 3.00
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 848 Design For Robots & Telerobots Units: 3.00
This course provides an overview of manipulator modeling, and presents and analyzes many different control architectures designed for robots and telerobots. Topics include introduction to robotics and telerobotics; serial manipulator forward and inverse kinematics, Jacobian, singularities and dynamics; robot position and force control methodologies and their stability analyses; bilateral teleoperation control architectures, stability and performance issues due to communication delays and environment uncertainties. Three term hours, Lectures, Winter. Dr. K Hashtrudi-Zaad
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 852 Broadband Integrated Circuits Units: 3.00
Topics covered include broadband and ultra wide band circuit design techniques with applications to wireless and lightwave systems. Broadband amplifiers, mixers and active filters are discussed through radio frequency, microwave and millimetre-wave techniques. Lightwave broadband adaptive filtering, transmitters and receivers are also discussed. Three term-hours; lectures A.P. Freundorfer.
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 853 Silicon Rf & Microwave Circuit Units: 3.00
This course presents an introduction to the design of RF and microwave circuits using silicon technologies. Topics include: an overview of silicon technologies; the design of passive structures including transmission lines, inductors, and couplers; considerations in the layout of active devices; examples of the design of circuit components on silicon; system design including integrated system-on-chip designs; and a look at the future of silicon high-speed circuits. Three term-hours, lectures; Winter. B. Frank
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 854 Microwave Circuits & Systems Units: 3.00
Investigation of the design and performance of wireless circuits and systems at microwave and millimeter-wave frequencies. Topics include: communications transceivers, millimeter-wave imaging systems, RFID, radar systems, transmission lines and passive circuits, resonators, microstrip and lumped element low-pass and bandpass filters, amplifier noise and linearity, diode and transistor mixers, LC and relaxation oscillators, frequency multipliers and dividers, phase shifters, FSK QPSK and GMSK modulators and demodulators. Three term hours; lectures. C. Saavedra.
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 855 Nanoelectronics and Nano-Devices Units: 3.00
This course teaches the fundamentals of electron devices in nanometer regime. The course will cover introduction to the nanoelectronics, basics of quantum mechanics and band theory of solids. The concept of Coulomb blockade, many electrons phenomenon, ballistic and spin transport will be discussed and single electron transistor, quantum dots, nanowire and quantum wells based devices
will be taught.
PREREQUISITES: ELEC 252, ENPH 336 or equivalent courses.
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 856 Introduction to Nanophotonics Units: 3.00
The course will provide an overview of the principles of operation of current nanophotonic devices, and recent advances in nanophotonics. Topics covered will include: light-matter interaction, optical waveguides, modeling of nanophotonic devices, light propagation in periodic and anisotropic media, coupled mode devices, plasmonics, metamaterial and metasurface. Emphasis of the course will be on the underlying physics behind the operation and design of nanophotonic devices.
PREREQUISITES: ELEC 381 or PHYS 239 or their equivalents.
Offering Faculty: Smith Engineering

ELEC 858 Principles Of Remote Sensing Units: 3.00
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 859 Unconventional Computing Units: 3.00
This course gives an overview of computing hardware from classic conventions to emerging frontiers: machine learning accelerators, quantum circuits, and others. It covers unconventional information representations, architectures, and programming. Assignments measuring cloud-based CPU, GPU, FPGA, neuromorphic, and quantum computers will give hands- on exposure to the physicality ¿ the time, energy, and matter ¿ of information processing. (3.0 credit units)
Offering Faculty: Smith Engineering

ELEC 860 Communication Network Analysis Units: 3.00
This course provides an analytical study of communication networks that covers many of the major advances made in this area. Students will be introduced to the mathematical preliminaries in queueing theory, optimization and control, followed by a rigorous treatment of network architectures, protocols and algorithms, including resource allocation, congestion control, routing, and scheduling that are essential to existing and future communication networks and the Internet.
PREREQUISITE: ELEC 326 (Probability and Random Processes) or equivalent.
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 861 Random Processes & Probability Units: 3.00
The review of probability theory including probability spaces, random variables, probability distribution and density functions, characteristic functions, convergence of random sequences, and laws of large numbers. Fundamental concepts of random processes including stationarity, ergodicity, autocorrelation function and power spectral density, and transmission of random processes through linear systems. Special random processes, including Gaussian processes, with applications to electrical and computer engineering at a rigorous level. Three term-hours; lectures. S. Gazor
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 863 Topics - Optical Communication Units: 3.00
Selected topics in optical communications will be studied. Possible topics include semiconductor lasers, optical modulators, modulation formats, multiplexing and demultiplexing techniques, optical fibers, dispersion compensation, optical amplifiers, optical receivers, system performance, optical time division multiplexing, optical signal processing (e.g., wavelength conversion, optical regeneration, clock recovery), passive components, optical networks, and applications (e.g., access, metro, long-haul, ultra-long haul). Three term-hours,lectures, Fall. J.C. Cartledge
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 864 Wdm Fiber Optic Comm. Systems Units: 3.00
This course presents the fundamentals of fiber optic communications, with focus on dense wavelength division multiplexed (DWDM) systems. Topics: components (lasers, modulators, receivers, and optical fibers) and detailed study of system issues in DWDM transmission (interplay between fiber dispersion and non-linearities, transmitter chirp, optical amplification, and polarization mode dispersion). Three term hours, lectures. S. Yam
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 865 Coding Theory Units: 3.00
The problem of reliable data transmission; communication and coding; error-detecting and error-correcting codes; classification of codes; introduction to algebra; linear block codes; cyclic codes; algebraic decoding,shift register encoding and decoding of cyclic codes; convolutional codes; Viterbi decoder; trellis codes; trellis decoding, trellis structure of codes; graphical representation ofcodes, block- and trellis-coded modulation, codes defined on graphs, turbo codes, iterative decoding, low-density parity-check codes. Three term-hours,lectures.S. Yousefi
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 866 Signal Detection & Estimation Units: 3.00
Vector space concepts. Hypothesis testing. Signal detection in discrete time including performance evaluation methods and sequential detection. Parameter estimation, including Bayesian, maximum-likelihood and minimum-variance unbiased estimation. Signal estimation in discrete time, including Kalman filtering, linear estimation, and Wiener filtering. Applications include communications, sensor array, image processing, and target tracking. Three term-hours; lectures. S.D. Blostein.
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 867 Data Communication Units: 3.00
Channel characterization and transmission impairments, performance evaluation, baseband pulse transmission, linear modulation, frequency and phase modulation, detection theory and system optimization, equalization, coded modulation. Three term-hours; lectures. P.J. McLane.
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 869 Mimo Communications Systems Units: 3.00
This course introduces fundamental theories of multiple-input multiple-output (MIMO) communications systems and design of space-time codes. Topic includes: MIMO channel models; capacity of MIMO systems; transmit and receive diversity; design criteria for space-time codes; space-time block codes; space-time trellis codes; layered space-time codes; differential space-time block codes; combined space-time codes and interference suppression; super-orthogonal space-time codes; variable rate space-time block codes. Three term-hours, lectures.I. Kim
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 870 Human-Robot Interaction Units: 3.00
This course focuses on the study and design of human-robot interactions (HRIs). Students will gain exposure to a broad cross-section of HRI research, exploring topics such as sensors and actuators, software architectures and design and evaluation tools. Selected HRI subdomains will be examined, including nonverbal communication, trust, and ethics. (3.0 credit units)
PREREQUISITE: ELEC 344 or similar course
CO-REQUISITES: ELEC 448 or MECH 456 or MREN 348 or similar from another university, OR permission of the instructor.
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 871 Shared-Memory Multiprocessing Units: 3.00
This course provides a comprehensive overview of shared-memory multiprocessing. Topics include: shared-memory programming, system and application software considerations, cache coherence protocols, memory consistency models, small-scale and large-scale shared-memory architectures, and case studies to explore practical considerations in multiprocessor systems ranging from single-chip implementations to scalable high-performance platforms.Three term hours; lectures. Winter. N. Manjikian
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 872 Artificial Intelligence and Interactive Systems Units: 3.00
Fundamental concepts and applications of intelligent and interactive system design and implementation. Topics include: (1) Sensors and Signals in Interactive Systems (2) Data Preprocessing: data acquisition, filtering, missing data, source separation, feature extraction, feature selection, dimensionality reduction; (3) Machine Learning: supervised learning, ensemble learning, multi-task learning, unsupervised learning; (4) Identity Recognition; (5) Activity Recognition and Analysis; (6) Affective Computing.
PREREQUISITE: ELEC 326 or equivalent, or permission of the instructor.
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 873 Cluster Computing Units: 3.00
This course covers topics related to network-based parallel computing systems. Issues related to clusters and computational "grid" such as interprocessor communications, message-passing and mixed mode paradigms and programming techniques, high performance interconnects, efficient host-network interface for fast messaging, lightweight user-level messaging layers and protocols, (network interface-assisted based) collective communications, communication latency tolerance techniques, power-aware high-performance computing, high performance file systems and I/O, benchmarking and performance evaluation, scheduling and load balancing, system-level middleware and computational grid applications and services will be discussed, Research papers from literature, a term paper and hands-on programming and experiments on a network of workstations will supplement the course. Three term-hours; lectures. A. Afsahi
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 874 Deep Learning in Computer Vision Units: 3.00
This course will study advances in Deep Learning as applied to the field of Computer Vision. The course will start with the introduction of AlexNet in 2012, and will advance chronologically, exploring the innovations that led to the significant improvements in performance. Topics covered will include object detection and recognition, region proposal networks, instance and semantic segmentation, depth and video processing.
PREREQUISITES: ELEC-474, ELEC-425 or equivalent, or permission of instructor.
Offering Faculty: School of Graduate Studies

ELEC 875 Software Design Recovery Units: 3.00
Design recovery is the extraction of a design model from the artifacts of an existing software system. This design model is used to continue the evolution of the system. The model can be used in the planning and impact analysis stage, while making the changes and to test the result. The extracted design model can also be used to automate each of these tasks to varying degrees. Topics include design models, design recovery techniques, software evolution tasks, the semantics of programming languages and execution environments, and source code transformation. Three term-hours, lectures, Winter, T. Dean.
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 876 Software Reengineering Units: 3.00
This course covers software reengineering techniques and tools that facilitate the evolution of legacy systems. This course is broken into three major parts. In the first part, the course discusses the terminology and the processes pertaining to software evolution. In the second part, the course provides the fundamental reengineering techniques to modernize legacy systems. These techniques include source code analysis, architecture recovery, and code restructuring. The last part of the course focuses on specific topics in software reengineering research. The topics include software refactoring strategies, migration to Object Oriented platforms, quality issues in reengineering processes, migration to network-centric environments, and software integration. Three term-hours, lectures, Fall, Y. Zou
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 877 AI for Cybersecurity Units: 3.00
This course covers the fundamentals of cybersecurity and machine learning, selected topics in machine learning for cybersecurity, including anomaly detection, malware analysis, network traffic analysis, and fake news defense, and the advanced topics in artificial intelligence (AI) security, including privacy-preserving AI, fairness in AI, and adversarial machine learning.
PREREQUISITE: ELEC-425 or equivalent, or permission of the instructor
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 878 Extreme Scale Networking Units: 3.00
This course will provide students with understanding of the field of Extreme-scale Systems with an emphasis on Extreme-Scale networks. Students will learn the fundamentals of Extreme-scale systems networks and an ability to read, understand, discuss and critique research. Use cases like Scientific computing, AI/ML, big data and commercial applications will be discussed. (3.0 credit units).
PREREQUISITE: ELEC 373 (networks) or equivalent. Pre-requisites may be waived with permission of the instructor.
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 879 Wearable and IoT Computing Units: 3.00
This course focuses on recent advances and computing trends in wearable technologies, mobile devices, the Internet of Things (IoT), smart homes, and smart vehicles. The history, background, and applications of these systems are reviewed, followed by the description of common sensing technologies often utilized in these devices. Signal/time-series analysis techniques, machine learning algorithms, and computing methods that are often utilized in such applications will be covered in detail. The course is highly applied and students will complete a project and present their results.
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 880 Machine Learning for Natural Language Processing Units: 3.00
Human (or natural) language data permeate almost all aspects of our daily life. This course covers basic machine learning approaches to modelling natural language, including fundamental supervised and unsupervised methods for modelling sequences and structures in the data. Based on this, students learn how to develop various applications such as chatbots and information extraction systems. The course will also include state-of-the-art artificial intelligence and deep learning approaches to natural language processing.
Offering Faculty: Smith Engineering

ELEC 886 Integrated Optical Waveguides Units: 3.00
Offering Term: F
Offering Faculty: Smith Engineering

ELEC 891 Seminar Units: 0.00
ECE graduate students must register in this non-credit course for the duration of their degree program. The student is given a Pass grade for this course upon attending a majority of seminars designated by ECE.
Offering Faculty: Smith Engineering

ELEC 895 Industrial Internship I Units: 3.00
The industrial internship involves spending a minimum of 4 months and a maximum of 8 months in a funded internship position in industry or government. Students in the 4 month internship must register in ELEC-895*. Students in the 8 month internship must register in ELEC-895* and ELEC-896*. Successful completion of the course requires submission of a report on the industrial project within thirty days of completion of the work period. Each project must be approved by the academic supervisor. Queen¿s University Career Services manages the non-academic aspects of the course.
Offering Faculty: Smith Engineering

ELEC 896 Industrial Internship II Units: 3.00
The industrial internship involves spending a minimum of 4 months and a maximum of 8 months in a funded internship position in industry or government. Students in the 4 month internship must register in ELEC-895*. Students in the 8 month internship must register in ELEC-895* and ELEC-896*. Successful completion of the course requires submission of a report on the industrial project within thirty days of completion of the work period. Each project must be approved by the academic supervisor. Queen¿s University Career Services manages the non-academic aspects of the course.
Offering Faculty: Smith Engineering

ELEC 897 Electrical Eng. Seminar Units: 3.00
Offering Term: FWS
Offering Faculty: Smith Engineering

ELEC 898 M. Eng. Project Units: 6.00
Offering Term: FWS
Offering Faculty: Smith Engineering

ELEC 899 M.Sc. Thesis Research Units: 6.00
Offering Term: FWS
Offering Faculty: Smith Engineering

ELEC 958 Adv. Integrated Circuit Design Units: 3.00
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 967 Data Communication Units: 3.00
Offering Term: W
Offering Faculty: Smith Engineering

ELEC 999 Ph. D. Thesis Research Units: 6.00
Offering Term: FWS
Offering Faculty: Smith Engineering