ELECTRICAL ENGINEERING (ELE)

ELE 500 Selected Topics (1-6 Credits)
Engineering & Comp Sci
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.
Repeatable

ELE 516 Control of Robots (3 Credits)
Engineering & Comp Sci
Cross-listed with CIS 543
Kinematics, dynamics, and control of mobile and/or manipulator robots. Path planning, actuators, sensors, human/machine interface. Two hours lecture and two hours laboratory weekly. Design project.

ELE 524 Introduction to Applied Optics (3 Credits)
Engineering & Comp Sci
Geometrical optics, two-dimensional Fourier transforms and wave propagation, optical fibers, Fresnel and Fraunhofer diffraction, interferometry, imaging and Fourier transforming properties of lenses, image processing, complex filters and holography. Includes laboratory: design and experiment.
Prereq: ELE 324

ELE 551 Communication Systems (3 Credits)
Engineering & Comp Sci
Communications systems. Amplitude modulation techniques. Angle modulation or frequency modulation. Sampling and quantization of analog signals. Basic digital modulation techniques. Introduction to noise. System modeling evaluating performance using industry tools.
Prereq: ELE 351

ELE 580 International Course (1-6 Credits)
Engineering & Comp Sci
Offered through SUAbroad by educational institution outside the United States. Student registers for the course at the foreign institution and is graded according to that institution's practice. SUAbroad works with the S.U. academic department to assign the appropriate course level, title, and grade for the student's transcript.

ELE 590 Independent Study (1-6 Credits)
Engineering & Comp Sci
Exploration of a problem, or problems, in depth. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor(s) and the department.
Repeatable

ELE 591 Special Problems in Electrical Engineering (1-4 Credits)
Engineering & Comp Sci
Students work on special projects. Instructors present new or special material.
Repeatable
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

ELE 601 Applications of Complex Function Theory (3 Credits)
Engineering & Comp Sci
Theory of functions of a complex variable. Fourier and Laplace transforms. Applications to engineering problems.

ELE 602 Boundary Value Problems I (3 Credits)
Engineering & Comp Sci
Partial differential equations in engineering problems. Method of separation of variable. Sturm-Liouville systems and orthogonal functions. Series and integral representations.

ELE 603 Functional Methods of Engineering Analysis (3 Credits)
Engineering & Comp Sci
Linear functional systems from the viewpoint of vector spaces. Function spaces, differential and integral operators, eigenvalues and eigenfunctions, Jordan forms, functions of a matrix and state-space solutions.

ELE 606 Probabilistic Methods in Electrical Engineering (3 Credits)
Engineering & Comp Sci
Set-theoretic basis of probability. Probabilistic modeling of practical problems. Random variables in one and several dimensions. Functions of random variables. Moments, characteristic functions, correlation, sampling. Poisson process. Laws of large numbers and central limit theorem.

ELE 612 Modern Control Systems (3 Credits)
Engineering & Comp Sci
State space representation. State variable feedback design. Controllability, observability, and identifiability. Optimum design and the matrix Ricatti equation.

ELE 614 Power System Analysis and Control (3 Credits)
Engineering & Comp Sci
Double-numbered with ELE 414
Three phase power systems, Power flow analysis, Symmetrical components, Fault analysis, Power system stability, Power system controls, Fundamentals of economic dispatch. Additional work required for graduate students.
Advisory recommendation Prereq for ELE 314
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/); Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

ELE 615 Microgrids (3 Credits)
Engineering & Comp Sci
Double-numbered with ELE 415
Challenges and opportunities in smart microgrids. Distributed energy resources in microgrids. Grid-connected and islanding mode of microgrid operation. Microgrid monitoring and protection. Control technology requirements and solutions. Additional work required for graduate students.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/)

ELE 617 Power Electronics (3 Credits)
Engineering & Comp Sci
Double-numbered with ELE 417
Semiconductor devices, switching power poles, switching analysis, topology selection and design, single phase and three phase rectifiers, inverters, and converters, feedback controllers and power supply. Additional work required of graduate students.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/)

ELE 618 Sensors & Measurements (3 Credits)
Engineering & Comp Sci
Double-numbered with ELE 418
Sensor signal domains, sensor classifications and architecture, sensor types, data acquisition methods, signal conversion methods, standards, introduction to metrology, measurement result processing, synchrophasor technology and applications. Additional work required of graduate students.

ELE 621 Electromagnetic Fields (3 Credits)
Engineering & Comp Sci
Development of electromagnetic theory from the basic postulates leading to Maxwell's equations in differential and integral forms. Solution to static, quasi-static, and wave-propagation problems.

ELE 623 Microwave Engineering Fundamentals (3 Credits)
Engineering & Comp Sci
Microwave engineering fundamentals including transmission line theory, impedance matching techniques, microwave network analysis and device characterization. Practical illustration of these concepts via network analyzer measurements, spectrum analyzer measurements, and computer based electromagnetic modeling tools.

ELE 625 High Frequency Transmission Systems (3 Credits)
Engineering & Comp Sci
Transmission line parameters, transients on lossless lines, time-harmonic excitation of lines, Smith chart, impedance matching techniques, matrix representation of multiport devices, coupled transmission systems, even and odd mode theory, circuit theory of rectangular waveguides.

ELE 633 Discrete and Integrated Analog Electronic Circuits (3 Credits)
Engineering & Comp Sci
Linear and non-linear circuit models of electronic devices as derived from structural and empirical parameters. Anatomy and applications of integrated operational amplifiers; active filters, multipliers, comparators, voltage-controlled oscillators, wave-form generators, phase-locked loops.

ELE 635 Digital Electronic Circuits (3 Credits)
Engineering & Comp Sci
Digital device and circuit technology and trends. Nanoscale semiconductor devices and memories as well as magnetic and optical memories. Semiconductor industry road map. Device fabrication techniques. DA and AD conversion circuits.

ELE 642 Introduction to Solid-State Physics (3 Credits)
Engineering & Comp Sci
Cross-listed with PHY 576
Elementary aspects of physics of solids; crystal lattices and diffraction, phonons and thermal properties in crystals, elementary band theory, and semi-conductor physics.
Advisory recommendation Prereq: PHY 567

ELE 643 Theory of Semiconductor Devices (3 Credits)
Engineering & Comp Sci
Fundamental theory of semiconductor devices and their linear and nonlinear mathematical and circuit models. Frequency response and switching characteristics of discrete and integrated structures comprising both bipolar and field effect devices.

ELE 651 Digital Communications (3 Credits)
Engineering & Comp Sci
Baseband data transmission. Advanced digital modulation techniques. Optimum receivers. Topics in information theory and coding.
Advisory recommendation Prereq: ELE 551

ELE 652 Digital Audio Signal Processing (3 Credits)
Engineering & Comp Sci
Double-numbered with ELE 452
Course combines classroom theory with hands-on lab. Covers digital audio fundamentals, filter-design, DSP architecture, parallel assembly programming, circular buffers, processing music signals. Additional work required of graduate students.

ELE 653 Image and Video Processing (3 Credits)
Engineering & Comp Sci
Double-numbered with ELE 453
Concepts and applications of image and video processing. Principles of image formation, low-level image processing methods, noise filtering, histogram processing, feature detection, face recognition, moving object detection and tracking, multi-camera systems. Significant project for graduate students.

ELE 654 Introduction to Radar Systems (3 Credits)
Engineering & Comp Sci
Double-numbered with ELE 454
Foundations of radar systems including basic radar measurements and functionality, the radar range equation, and fundamentals of search and detection. Overview of major subsystems including antennas, transmitters, receivers and signal processors. Introduction to radar signal processing techniques. Additional work required for graduate students.

ELE 658 Data Networks: Design and Performance (3 Credits)
Engineering & Comp Sci
Cross-listed with CSE 658
Data network design principles. Performance, modeling, and analysis of networks. Delay models. Multi-access communications. Routing and flow control algorithms. Familiarity with basics of data networks.
Advisory recommendation Prereq: CIS 321 or MAT 521; Coreq: ELE 606

ELE 659 Digital Signal Processing I (3 Credits)
Engineering & Comp Sci
Discrete time signals. Z-transform. Discrete Fourier transform. Fast Fourier transform. Finite impulse response filters. Infinite impulse response filters. Effects of finite word length.

ELE 664 Introduction to System-on-Chip Design (3 Credits)
Engineering & Comp Sci
Cross-listed with CSE 664
Design principles and fabrication of computer chips. Standard cell based system-on-chip design, top down design flow, RT level design and synthesis, pipelining and performance analysis, software-hardware co-design and co-simulation.

ELE 667 Embedded System Design (3 Credits)
Engineering & Comp Sci
Cross-listed with CSE 671
Methodologies for systematic design of embedded systems. System specification, architecture modeling, component partitioning, estimation metrics, hardware software co-design. Embedded computing platforms and programming. ASIC, CPU, and glue logic. Individual project required.

ELE 670 Experience Credit (1-6 Credits)
Engineering & Comp Sci
Participation in a discipline or subject related experience. Student must be evaluated by written or oral reports or an examination. Permission in advance with the consent of the department chairperson, instructor, and dean. Limited to those in good academic standing.
Repeatable

ELE 681 Introduction to Photonic Engineering (3 Credits)
Engineering & Comp Sci
Topics include: geometrical theory; optical diffraction theory; angular spectral propagation theory; Fresnel and Frauhofer integral solutions; gaussian beam theory; reflection and refraction; mathematics of polarization; lenses and lenslike media; and photons and atoms.

ELE 682 Fiber Optic Communication (3 Credits)
Engineering & Comp Sci
Topics include: 1) network structures; 2) links; 3) full nets; 4) measures of networks; 5) conductivity; 6) transfer rates; 7) present network constraints; 8) new demands on networks; 9) architectures and interconnections; 10) instrumentation for analysis; and 11) control, regulation, and standardization.

ELE 683 Infrared Engineering (3 Credits)
Engineering & Comp Sci
Topics include: 1) review of optical diffraction theory; 2) radiometry; 3) blackbody radiation theory; 4) IR sources; 5) atmospheric IR transmissions; 6) IR optics; 7) IR detectors and noise; 8) IR lasers; 9) passive systems; and 10) active, heterodyne IR radar systems.

ELE 685 Photonic Devices (3 Credits)
Engineering & Comp Sci
Topics include: 1) electro optic detectors; 2) photo diodes; 3) avalanche photo-diodes; 4) multi-quantum well detectors; 5) photo-multipliers; 6) micro-channel plates; 7) multi-quantum well modulators; 8) Mach-Zhender modulators and switches; 9) couplers; 10) wavelength division couplers; and 11) grating devices.

ELE 690 Independent Study (1-6 Credits)
Engineering & Comp Sci
Exploration of a problem, or problems, in depth. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor(s) and the department.
Repeatable

ELE 691 Special Topics in Electrical Engineering (1-4 Credits)
Engineering & Comp Sci
Topics vary and represent current interests in electrical engineering.
Repeatable

ELE 702 Boundary Value Problems II (3 Credits)
Engineering & Comp Sci
Continuation of ELE 602. Green's functions, integral equations, transform methods, and approximation techniques.
Advisory recommendation Prereq: ELE 601, 602

ELE 703 Convex Optimization (3 Credits)
Engineering & Comp Sci
Concepts and applications of convex optimization. Topics include convex sets, convex functions, linear programming, quadratic programming, semidefinite programming, duality theory, software tools.

ELE 704 Neural Networks and Fuzzy Logic Applications (3 Credits)
Engineering & Comp Sci
Neural networks and fuzzy logic to develop algorithms and computer programs for engineering and other applications, such as financial, medical, and sociological. Use non-parametric statistics to measure performance.
Advisory recommendation Prereq: ELE 603

ELE 712 Optimal Control Systems (3 Credits)
Engineering & Comp Sci
Performance criteria and static optimization. The Maximum Principle. Optimum regulator problem. Dynamic programming. Gradient methods for dynamic optimization.
Advisory recommendation Prereq: ELE 612

ELE 715 Robot Manipulators I (3 Credits)
Engineering & Comp Sci
Cross-listed with MEE 715
Robot manipulators and their defining equations. Transformations, kinematics, dynamics, and motion trajectories. Control considerations, compliance and organization of programming. Includes a hardware and software laboratory.
Advisory recommendation Prereq: ELE 612

ELE 721 Antennas and Antenna Systems (3 Credits)
Engineering & Comp Sci
Characteristics of electromagnetic radiators. Equivalent circuits of antenna elements: dipoles, loops, helices, horns, and other radiators. Phased arrays. Pattern synthesis. Numerical methods. Broadband antennas. Measurement techniques.
Advisory recommendation Prereq: ELE 621

ELE 722 Microwave Filters (3 Credits)
Engineering & Comp Sci
General filter structures at microwave frequencies. Prototype filters obtained by network synthesis method. Image parameters. Richards' transformation. Kuroda Identities. Coupled-line equivalent circuits. Design, simulate, build, and test a microwave filter.
Advisory recommendation Prereq: ELE 623

ELE 723 Microwave Transistor Amplifiers (3 Credits)
Engineering & Comp Sci
Two-port network representations, matching networks, power gain equations, stability conditions, simultaneous conjugate match, constant gain, VSWR and noise figure circles, balanced and feedback amplifiers. Design, simulate, build, and test a microwave amplifier.
Advisory recommendation Prereq: ELE 623

ELE 724 Microwave Oscillators (3 Credits)
Engineering & Comp Sci
Matching networks, S-parameters. Oscillation conditions, One-port and two-port Negative-resistance Oscillators, oscillator design using large-signal measurements, DROs, YIG Oscillators, VCOs, and Phase noise. Design, simulate, build, and test a microwave oscillator.
Advisory recommendation Prereq: ELE 623

ELE 725 Electromagnetic Engineering I (3 Credits)
Engineering & Comp Sci
Time varying electromagnetic fields. Field theorems, propagation and reflection of waves, wave guides, resonators, radiation, and diffraction. Applications to antenna theory.
Advisory recommendation Prereq: ELE 621

ELE 726 Computational Methods of Field Theory (3 Credits)
Engineering & Comp Sci
Functional analysis, method of moments, and variational methods. Applications to electrostatics, magnetostatics, two-dimensional electromagnetic fields, antennas, scatterers, and apertures.
Advisory recommendation Prereq: ELE 621

ELE 728 Planar Microwave Antennas (3 Credits)
Engineering & Comp Sci
Review of the fundamentals of antennas. Theory of microstrip antennas, dual and circularly polarized antennas, feeding techniques, mutual coupling, arrays of patches, effect of substrate and the ground plane. Design, simulate, build, and test a planar microwave antenna.

ELE 735 Digital Electronic Crcts (3 Credits)
Engineering & Comp Sci

ELE 742 Electronic Materials (3 Credits)
Engineering & Comp Sci
Electronic properties of dielectric, magnetic, and superconducting materials. Application to devices.
Advisory recommendation Prereq: ELE 621

ELE 751 Wireless Communications (3 Credits)
Engineering & Comp Sci
Cellular communication systems. Mobile radio propagation. Modulation techniques. Equalization, diversity, and channel coding. Link budget analysis. Speech coding. Multiple access techniques. Spread spectrum systems and CDMA. Wireless systems and networking.
Advisory recommendation Prereq: ELE 606 and 651

ELE 752 Coding Theory and Its Applications (3 Credits)
Engineering & Comp Sci
Algebra or error correcting codes, finite fields, cyclic codes, BCH codes, Convolutional codes, Viterbi and stack algorithms. Applications to communications and data storage systems.
Advisory recommendation Prereq: ELE 606 and 651

ELE 753 Radar Engineering (3 Credits)
Engineering & Comp Sci
Radar system requirements and principles of radar detection and parameter estimation. Factors affecting radar range, signal detection in noise, decision criteria. Target identification techniques. Radar antenna characteristics. Time-space-frequency-phase interrelationships.
Advisory recommendation Prereq: ELE 651

ELE 755 Digital Image Processing (3 Credits)
Engineering & Comp Sci
Two-dimensional signals and systems. Image formation and perception. Representation, coding, filtering, restoration, and enhancement. Feature extraction and scene analysis. Introduction to computer vision.
Advisory recommendation Prereq: ELE 601, 659

ELE 756 Random Processes (3 Credits)
Engineering & Comp Sci
Stationary and nonstationary random processes. Gaussian process. Narrow-band representation. Response of linear filters and nonlinear detectors to random processes. Applications to communication problems.
Advisory recommendation Prereq: ELE 606; Coreq: ELE 651

ELE 757 Information Theory (3 Credits)
Engineering & Comp Sci
Basic information measures. Source coding. Capacity of discrete channels. Coding theorem for noisy channel. Concepts of error correction codes. Extensions to continuous and wave form channels.
Advisory recommendation Prereq: ELE 606; Coreq: ELE 651

ELE 758 Selected Topics in Data Networks (3 Credits)
Engineering & Comp Sci
Topics vary each term. Typical topics: Gigabit networks, network security, ATM networks, and personal communication networks.
Repeatable
Advisory recommendation Prereq: ELE 658

ELE 759 Digital Signal Process II (3 Credits)
Engineering & Comp Sci
Spectral analysis with Fast Fourier transform. Advanced filtering algorithms. Multichannel signal processing. Selected topics on DSP applications.
Advisory recommendation Prereq: ELE 659

ELE 761 VLSI Timing Analysis (3 Credits)
Engineering & Comp Sci
Cross-listed with CSE 731
Delay modeling and timing analysis of interconnections and gates. Critical path analysis and delay budgeting. Buffer insertion and device sizing. Switch and circuit level simulations.

ELE 762 Computer-Aided Design for VLSI and Digital Systems (3 Credits)
Engineering & Comp Sci
Cross-listed with CSE 788
Computer aids for automatic physical design of digital systems. Algorithms for partitioning, placement, wire routing, layout compaction, etc. Programming competence required.

ELE 765 System Verification and Testing (3 Credits)
Engineering & Comp Sci
Cross-listed with CSE 765
Concepts, methods, and technology for effective verification of complex systems. Coverage metrics, event- and assertion-based verification, and formal methods including model checking and logical equivalence checking. Testing strategies, architecting testbenches, and design for verification.

ELE 781 Dielectric Waveguides and Fibers (3 Credits)
Engineering & Comp Sci
Topics include: 1) propagating and radiating modes in dielectric waveguides; 2) circular waveguides-fibers; 3) modes in fibers; 4) single mode fibers; 5) Raleigh and Raman effects and losses in fibers; and 6) practical experiments in laboratory.
Advisory recommendation Prereq: ELE 621 or ELE 681

ELE 784 Optical Information Processing (3 Credits)
Engineering & Comp Sci
Fourier transforming and imaging properties of lenses. 2-D linear systems. Frequency analysis. 2-D information processing, synthetic aperture radar, planar and volume holography and applications. Bragg diffraction, optical memory and photonics in computing systems.
Advisory recommendation Prereq: ELE 681

ELE 786 Laser Propagation and Modulation (3 Credits)
Engineering & Comp Sci
Topics include: 1) wave propagation in anisotropic media, 2) index modulation tensors, 3) bifringent toptical systems, 4) periodic media, 5) acousto-optics, 6) electro-optic effects, 7) second harmonic generation, 8) phase conjugation, and 9) nonlinear optics.
Advisory recommendation Prereq: ELE 681

ELE 787 Lasers (3 Credits)
Engineering & Comp Sci
Review of quantum mechanics, review of light propagation theory. Interaction of light and atoms and electrons. Rate equations. Mode locking and Q. switching, gas, solid-state and semiconductor lasers, laboratory experiments/demonstrations.
Advisory recommendation Prereq: ELE 681

ELE 790 Independent Study (1-6 Credits)
Engineering & Comp Sci
Exploration of a problem, or problems, in depth. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor(s) and the department.
Repeatable

ELE 791 Advanced Topics in Electrical Engineering (1-4 Credits)
Engineering & Comp Sci
Topics vary and represent current interests in electrical engineering. Each offering has a graduate-level prerequisite.
Repeatable

ELE 821 Special Topics in Electromagnetic Theory (3 Credits)
Engineering & Comp Sci
Advanced and current topics in electromagnetic theory. Topics vary each term. May include: array theory, electromagnetic compatibility, numerical methods, propagation and radiation in ionized media, moving media, and random media.
Repeatable

ELE 827 Electromagnetic Engineering II (3 Credits)
Engineering & Comp Sci
Modern methods for solving electromagnetic field problems. Equivalence theorems, Green's function techniques, integral equations, variational solutions and transform solutions.
Advisory recommendation Prereq: ELE 725

ELE 847 Semiconductor Optoelectronics (3 Credits)
Engineering & Comp Sci
Optical and optoelectronic properties of semiconductors. Applications to lasers, lamps, photodetectors, and solar cells.
Advisory recommendation Prereq: ELE 643

ELE 849 Special Topics in Solid State (3 Credits)
Engineering & Comp Sci
Modern methods for analyzing the quantum normal modes of materials in the solid state and their technological applications. May be repeated for credit with instructor's consent.

ELE 851 Detection and Estimation Theory (3 Credits)
Engineering & Comp Sci
Hypothesis testing and parameter estimation. Series representation of random processes. Detection and estimation of known signals in white and nonwhite Gaussian noise. Detection of signals with unwanted parameters.
Advisory recommendation Prereq: ELE 756

ELE 852 Kalman Filters (3 Credits)
Engineering & Comp Sci
Models for linear systems and stochastic processes, estimation techniques, Kalman filter derivation using innovations and Bayesian approaches, Kalman filter for Gauss-Markov model, Kalman filter design methodology, extended Kalman filters.
Advisory recommendation Prereq: ELE 603, 756

ELE 853 Advanced Topics in Communication Theory (3 Credits)
Engineering & Comp Sci
Typical topics: spread-spectrum techniques, synchronous communications, signal theory, spectral estimation, radar and sonar applications of detection and estimation theory.
Repeatable
Advisory recommendation Prereq: ELE 756

ELE 890 Independent Study (1-6 Credits)
Engineering & Comp Sci
Exploration of a problem, or problems, in depth. Individual independent study upon a plan submitted by the student. Admission by permission of supervising instructor or instructor and the department.
Repeatable

ELE 891 Special Problems in Electrical Engineering (1-4 Credits)
Engineering & Comp Sci
Repeatable

ELE 970 Experience Credit (1-6 Credits)
Engineering & Comp Sci
Participation in a discipline or subject related experience. Student must be evaluated by written or oral reports or an examination. Permission in advance with the consent of the department chairperson, instructor, and dean. Limited to those in good academic standing.
Repeatable

ELE 990 Independent Study (1-6 Credits)
Engineering & Comp Sci
Exploration of a problem, or problems, in depth. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor(s) and the department.
Repeatable

ELE 995 Engineer Degree Project (0-6 Credits)
Engineering & Comp Sci
Independent investigation or original research on an engineering problem under supervision of member of the faculty. Credit to be arranged.
Repeatable

ELE 996 Master's Project (0 Credits)
Engineering & Comp Sci
An engineering investigation or the analysis and evaluation of a journal paper. A written report is required in accordance with current departmental guidelines. Required of all students electing the nonthesis option for the master's degree.
Repeatable

ELE 997 Masters Thesis (1-6 Credits)
Engineering & Comp Sci
Independent investigation on a topic of interest under supervision of a member of the Graduate School faculty. Credits to be arranged.
Repeatable

ELE 999 Dissertation for the PhD (1-15 Credits)
Engineering & Comp Sci
Research work on a doctoral dissertation under the supervision of a member of the Graduate School faculty. Credits to be arranged.
Repeatable