ELECTRICAL ENGINEERING (ELEC)

ELEC 5005 - IC Design (3 Credits)
Explores digital integrated circuit design including MOS processing steps, physical operation, building blocks of digital circuits, advanced nMOS, pMOS and CMOS circuit design, silicon VLSI technology and circuit and chip level. Spice and lay-out Editor are used. The physical relationship between circuit design and actual silicon layout and structure and technology are emphasized. Prereq: Graduate standing or permission of instructor. Cross-listed with ELEC 4005. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to students with graduate standing.

ELEC 5025 - Device Electronics (3 Credits)
A course relating performance and limitations of solid state devices to their structures and technology. For both advanced circuit and device engineers. Semiconductor physics and technology, pn-junction and MOS devices used in modern integrated circuits. Prereq: ELEC 3225 and senior standing. Cross-listed with ELEC 4025. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 3225 Restriction: Senior standing

ELEC 5033 - Advanced Electromagnetic Fields (3 Credits)
A course focused on electromagnetic waves. Topics include: Poynting's power theorem, reflection and transmission of uniform plane waves in layered media, two-conductor transmission lines, rectangular wave guides, Smith Chart elements of radiation and antenna. Prereq: ELEC 3133 and permission of instructor for undergraduates. Cross-listed with ELEC 4133. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 3133 or ELEC 5033

ELEC 5133 - Electromagnetic Radiation and Antenna (3 Credits)
Grading Basis: Letter Grade
Prereq: ELEC 4133 or ELEC 5033

ELEC 5134 - Introduction to Microwave Circuit Design (3 Credits)
This course provides the basic principles of microwave circuit design, including transmission line theory, network parameters, signal flow graphs, design of high frequency matching networks, filters, hybrids and couplers using waveguide elements, high frequency amplifier and mixer design. Prereq: ELEC 3133. Cross-listed with ELEC 4134. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 3133 or graduate standing

ELEC 5154 - Electric and Hybrid Vehicle Powertrains (3 Credits)
Covers the fundamental components and operation of electric and hybrid vehicles' drivetrain. Topics include electric vehicle history, major vehicle components, fundamental vehicle dynamics, electric and hybrid drivetrain configurations, electric motors and drives, energy storage, and power electronics chargers. Cross-listed with ELEC 4154. Max hours: 3 Credits.
Grading Basis: Letter Grade
Typically Offered: Fall.

ELEC 5164 - Electric Machines and Drives (3 Credits)
Covers power electronics drives for rotating electric machinery. Topics include power electronics elements for drives, load characteristics, dynamic modeling of AC machines, fundamental control algorithms, simulation and practical commercial drives. Prereq: ELEC 3164. Cross-listed with ELEC 4164. Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.
Typically Offered: Fall.

ELEC 5170 - Electric Machines and Drives Laboratory (1 Credit)
Offers hands-on experience on rotating electric machine drive simulations and commercial systems. Sessions include pulse-width modulation (PWM) inverter, induction, DC, and synchronous machine drives. Matlab/Simulink and a commercial inverter will be utilized. Prereq: ELEC 4164 or equivalent. Cross-listed with ELEC 4170. Max hours: 1 Credit.
Grading Basis: Letter Grade

ELEC 5174 - Power Electronic Systems (3 Credits)
Topics to be covered include: power electronics fundamentals and applications in power systems; uncontrolled, semi-controlled and fully controlled power semiconductors; converters design and control. Prereq: ELEC 3164 and graduate standing or permission of instructor. Cross-listed with ELEC 4174. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 3164 or Graduate Standing

ELEC 5184 - Power Systems Analysis (3 Credits)
Topics to be covered include: complex power, per-unit quantities; modeling of generators, transformers and transmission lines; power flow problem; economic dispatch; faults and sequence networks; and an introduction to power system protection and dynamics. Prereq: ELEC 3164 and graduate standing or permission of instructor. Cross-listed with ELEC 4184. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 3164 or Graduate Standing

ELEC 5194 - Power Systems Operation and Control (3 Credits)
This course introduces the student to various operational strategies the power industry uses today to operate the power system. Topics to be covered include: economic dispatch, unit commitment, optimal power flow (linear and nonlinear), transmission congestion, control areas, state estimation, and an introduction to power markets. Prereq: ELEC 4184 or ELEC 5184 or graduate standing. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 4184 or ELEC 5184 or graduate standing.

ELEC 5210 - Optimization Methods in Engineering (3 Credits)
Unconstrained optimization, gradient methods, conjugate direction methods, data fitting and function estimation. Applications in control, system identification and radar systems. Optimization over a convex set, LMS algorithms in adaptive systems, convergence properties. Nonlinear programming, Lagrange multipliers, projection algorithms, games and minimax theorem, application to H infinity control, communication and signal processing. Prereq: MATH 3191 and 3200/3195. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: MATH 3191 and (3200 or 3195)
ELEC 5212 - Fundamentals of Reliability Engineering (3 Credits)
Reliability Engineering is a critical part of systems engineering and sustainability design. There are four objectives of this course: 1) to introduce systems and controls in the design process, 2) to apply reliability fundamentals to civil, computer science, bio-engineering, mechanical, and electrical engineering projects and systems, 3) to employ and explore sustainability design in engineering projects, and 4) to prepare for the American Society of Quality Control (ASQC) test: the Certified Reliability Engineer Certification (CRE). Restriction: Graduate Standing. Cross-listed with ELEC 4212. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Graduate level students.
Typically Offered: Summer.

ELEC 5220 - Methods of Engineering Analysis (3 Credits)
Grading Basis: Letter Grade
Prereq: (MATH 3191 and 3200) or MATH 3195 or Graduate Standing

ELEC 5230 - Advanced Linear Systems (3 Credits)
Mathematical description of both continuous and discrete-time systems; vector, normed and inner-product spaces; state-space, impulse response and transfer function descriptions; state-transition response matrices; eigenvalues and eigenfunctions; controllability; canonical form; state feedback; observers; realization theory. Prereq: MATH 3191, MATH 3200/3195 and permission of instructor. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: (MATH 3191 and 3200) or MATH 3195 or Graduate Standing

ELEC 5248 - Digital Communication Systems (3 Credits)
Introduces digital communication systems covering elements of information theory; mathematical representation of signals and systems; modulation and demodulation for the additive Gaussian noise channel; Performance analysis of various transmission formats; synchronization; coded waveforms; decoding algorithms; and other related topics. Prereq: ELEC 3316, 3817; recommended ELEC 4247. Cross-listed with ELEC 4248. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: (ELEC 3316 and 3817) OR Graduate Standing

ELEC 5249 - Wireless Networking (3 Credits)
Fundamentals of wireless communication from a physical-layer perspective. Multipath signal propagation and fading channel models. Design of constellations to exploit time, frequency, and spatial diversity. Reliable communication and single-user capacity. Interference management, multiple-access protocols, and multi-user capacity. Cellular uplink and downlink. Multiple-antenna systems and architectures. Communications with Intelligent Reflecting Surfaces. mmWave and THz communications. Connections to modern standards. Prereq: Elec 3817 and Elec 3316. Cross-listed with ELEC 4249. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 3316 and ELEC 3817

ELEC 5250 - Information Inference and Learning Algorithms (3 Credits)
We indulge in a journey from the theory of information to the world of applications. We talk about what information means and provide the means to measure it. We then investigate various methods for extracting what matters from the available data. We bring in topics such as Bayesian data modeling, clustering algorithms, and neural networks to name a few. Prereq: ELEC 3817 or CSCI 4535 or MATH 3800. Cross-listed with ELEC 4250. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 3817 OR CSCI 4535 OR MATH 3800 OR Graduate Standing

ELEC 5252 - Computer Communication Networks (3 Credits)
Comprehensive study of issues arising in modern computer-communication networks, both wire-line and wireless, carrying traffics with heterogeneous characteristics. A conceptual and analytical approach to the design of network protocols in harmony with the appropriate modeling of the traffic and network environments. Issues covered include routing, transmission, performance monitoring, as well as and network management in ATM multi-media networks. Prereq: Graduate standing or permission of instructor. Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5276 - Digital Control Systems (3 Credits)
Analysis and design of discrete-time systems, as occurs when a digital computer is used to control physical systems. Topics include difference equations, Z-transform, sampled-data system modeling, sampling, discrete equivalents, stability, and discrete control design by root locus, direct design, frequency-response, and state space. Prereq: ELEC 3316, ELEC 3817, and graduate standing. Cross-listed with ELEC 4276. Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.
Prereq: ELEC 4136 or Graduate Standing

ELEC 5294 - Advanced Power Electronic Systems (3 Credits)
The course focuses on the design, modeling, modulation, control and simulation of three-phase two-level voltage sourced inverters with emphasis on applications. Student will also be introduced to advanced topologies including diode clamped multilevel inverters, modular multilevel inverters and matrix converters. Prereq: ELEC 4174 or ELEC 5174. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 4174 or 5174

ELEC 5333 - Introduction to Computational Electromagnetics (3 Credits)
An intro to computational electromagnetics based on the Finite Difference Time-Domain (FDTD) covering, finite difference methods, the Yee algorithm, numerical error, stability, boundary conditions, source excitations, hands-on programming experience and application of FDTD to real problems. Prereq: ELEC 3133 or grad standing. Cross-listed with ELEC 4333. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 3133 or graduate standing

ELEC 5334 - Advanced Computational Electromagnetics (3 Credits)
This course on advanced computational electromagnetics covers Green's theorems and identities, vector potential theory, equivalence principles, numerical linear algebra, numerical integration, method of weighted residuals, integral equation methods, method of moments, and Prereq: ELEC 4133 or ELEC 5133 or grad standing. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 4133 or ELEC 5133 or grad standing
ELEC 5373 - Optical Engineering (3 Credits)
This course introduces some of the most important concepts in optical engineering and prepares students a solid foundation to apply them to applications in the industry and academic research. Prereq: ELEC 3133. Cross-listed with ELEC 4373. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 3133 Restriction: Restricted to students within the College of Engineering, Design and Computing

ELEC 5375 - Engineering Neuroscience (3 Credits)
In this course, mathematical models and data processing strategies will be introduced as well as other cutting-edge research techniques to help students understand how these techniques can be applied to solve modern neuroscience problems. Prereq: ELEC 3316 or graduate standing. Cross-listed with ELEC 4735 and NRSC 7674 (Anschutz Medical Campus course). Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5423 - Radio Frequency Laboratory (1 Credit)
Projects involve modern RF analyzers, waveguide devices, time-domain techniques, characterization of devices, signal propagation and scattering, harmonic mixing, and radio frequency identification. Students will gain experience using MATLAB for data acquisition and processing. Graduate students will explore projects in greater detail. Cross-listed with ELEC 4423. Max Hours: 1 Credit.
Grading Basis: Letter Grade
Typically Offered: Fall, Spring.

ELEC 5433 - Fundamentals and Applications of Plasmas (3 Credits)
This course provides an introduction to plasmas, also known as the fourth state of matter, in nature and industry. Topics covered include single particle motions, plasma kinetic and fluid theory, cold and warm plasma models and interaction of electromagnetic waves with plasmas. Applications ranging from space sciences to medicine are explored. Prereq: ELEC 3133 for undergraduate students or permission of the instructor. No prerequisite for CEDC graduate students. Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5436 - Nonlinear Control Systems I (3 Credits)
Grading Basis: Letter Grade
Prereq: ELEC 4136 or ELEC 4276 or Graduate Engineering
Typically Offered: Fall, Spring.

ELEC 5444 - Power System Laboratory (1 Credit)
This lab introduces the student to modern computational tools used in power system analysis. Algorithms to solve the "power flow problem", the "economic dispatch problem", and the "optimal power flow problem" are discussed and implemented in the Matlab-Simulink mathematical analysis software package. Coreq: ELEC 4184. Max hours: 1 Credit.
Grading Basis: Letter Grade
Coreq: ELEC 4184.
ELEC 5486 - Modeling and System Identification (3 Credits)
Prereq: ELEC 3817 or MATH 3800, and ELEC 4136 or 4276. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Pre-req: (ELEC 3817 or MATH 3800) AND (ELEC 4136 or 4276) OR Graduate Standing

ELEC 5496 - Robust Control (3 Credits)
Background mathematics: function spaces and operators, and factorization theory. Stability theory: stability and stabilizability parameterization, closed-loop transfer matrices. Model-Matching Theory: solution existence, SISO Design, the Nehari problem. Performance bounds. Prereq: Graduate standing or permission of instructor. Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5501 - Microprocessor-Based Design (3 Credits)
Covers advanced treatment of embedded system design using microprocessors. Analog input circuitry is interfaced to a microprocessor, and a PC board layout is created to develop a complete system design. Software/Operating System is implemented for realtime I/O. Prereq: Graduate standing or permission of instructor. Cross-listed with ELEC 4501. Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5511 - Hardware-Software Interface (3 Credits)
Computer engineering methods in hardware and software design applied to problems drawn from the mini- and micro-computer systems field. Hardware and software techniques for the design of combined hardware or software are developed. Interface and real-time programming techniques are considered. Graduate level requires additional projects and homework. Prereq: ELEC 3520. Cross-listed with ELEC 4511. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Pre-req: ELEC 3520.

ELEC 5521 - Design and Test of Digital Systems (3 Credits)
Application of hardware description languages to the design, simulation, analysis, and testing of digital and computer systems; modeling and simulation constructs; modern hardware description languages, including VHDL, logic and behavioral synthesis; rapid-prototyping; FPGA and standard-cel ASIC design; design for testability; and electronic design automation. Prereq: ELEC 3651 or graduate standing. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Pre-req: ELEC 3651 or Graduate Standing

ELEC 5522 - VLSI Systems (3 Credits)
Examines the design of very large-scale integrated (VLSI) systems from the logic to physical levels, including MOS transistor design, CMOS fabrication and design rules, device and wafer processing, inverter and complex gate design, mask level layout, VLSI system components and architectures, algorithms for VLSI computer-aided design, and testability.
Prereq: ELEC 3215 and 3651 or graduate standing. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Pre-req: (ELEC 3215 and 3651) or Graduate Standing

ELEC 5531 - Introduction to Deep learning and PyTorch (3 Credits)
This course provides a foundation on neural networks of deep learning. Students will gain both theoretical and practical understanding of different deep neural networks and will work on a few real-world problems. Prereq: ELEC 3520. Cross-listed with ELEC 4531. Max hours: 3 Credits.
Grading Basis: Letter Grade
Pre-req: ELEC 3520.
Typically Offered: Spring, Summer.

ELEC 5541 - Advanced Deep Learning for Computer Vision (3 Credits)
This course introduces the state-of-the-art deep learning research work. Students will gain both theoretical and practical understanding of deep learning in computer vision area. Prereq: ELEC 3520. Cross-listed with ELEC 4541. Max hours: 3 Credits.
Grading Basis: Letter Grade
Pre-req: ELEC 3520.
Typically Offered: Spring, Summer.

ELEC 5551 - Pattern Recognition (3 Credits)
Pattern recognition techniques from image processing and artificial intelligence are explored. Topics include neural networks, morphological processing, wavelets, fractals, and basic image understanding. Prereq: ELEC 3316 and 3651. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Pre-req: (ELEC 3316 and 3651) or Graduate Standing

ELEC 5555 - VLSI Circuits Simulation (3 Credits)
Grading Basis: Letter Grade

ELEC 5560 - Random Processes for Engineers (3 Credits)
Probability, sequences of random variables, specification of stochastic processes, stationarity, correlation functions and spectral densities, linear mean-square estimation, central limit theorems, law of large numbers, non-stationary random processes, stochastic differential equations and Karhunen-Loeve expansion, Kalman filtering. Prereq: ELEC 3316 and ELEC 3817 and permission of instructor. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Pre-req: (ELEC 3316 and 3817) OR Graduate Standing

ELEC 5567 - Stochastic Point Processes (3 Credits)
Presents modeling physical phenomena characterized by highly localized events distributed randomly in a continuum. Applications include optical communications, queuing theory, decision theory, nuclear medicine and electron microscopy. Topics include Poisson counting processes and its generalizations; stochastic differential equations used in filtering; martingales and Brownian motion. Prereq: ELEC 3817 or ELEC 5617. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Pre-req: ELEC 3817 or 5617
ELEC 5637 - Digital Signal Processing (3 Credits)
Grading Basis: Letter Grade
Prereq: (ELEC 3316 and 3817) OR Graduate Standing

ELEC 5638 - Digital Image Processing (3 Credits)
Basics of two-dimensional (2-D) systems theory, including 2-D Fourier transform, Z-transform, and difference equations. Design of 2-D filters for image processing applications. Image transforms, including the 2-D FFT, cosine, Hadamard and KL. Image enhancement and restoration techniques. Method of image coding and compression. Prereq: ELEC 3133, 3215, 3225, 3316, 3817 or graduate standing. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 3133, 3215, 3225, 3316, 3817 or graduate standing

ELEC 5644 - Introduction to Medical Imaging (3 Credits)
This course will introduce students to the basic physics, technologies, and clinical methodologies underlying Ultrasound, MRI, CT, PET and SPECT imaging systems. The course will include lectures, and visits to campus hospital and research imaging systems as well as hands on ultrasound labs. Prereq: Graduate standing. Cross-listed with ELEC 4644. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Graduate level students.

ELEC 5647 - Adaptive Signal Processing (3 Credits)
Grading Basis: Letter Grade
Prereq: ELEC 5637

ELEC 5648 - Blind Signal Processing (3 Credits)
Restriction: Restricted to graduate students

ELEC 5657 - Detection and Estimation Theory (3 Credits)
Introduces detection and extraction methods used in signal processing, including decision theory; detection of known and random signals; optimum receiver design; estimation theory; Wiener filtering; Kalman-Bucy filtering; and applications to communication systems. Prereq: ELEC 5617. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 5617

ELEC 5678 - Quantum Computing (3 Credits)
The course teaches students the principles, the algorithms and the programming methods of quantum computing, and also discusses the associated physics and mathematics background required. Other related topics such as quantum communication and quantum entanglement will also be discussed. Prereq: Graduate standing. Cross-listed with ELEC 4678, PHYS 4678, and PHYS 5678. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Graduate level students.

ELEC 5679 - Quantum Computing Algorithms (3 Credits)
The course discusses several seminal quantum algorithms, including the quantum Fourier transforms, Grover's and Shor's algorithms, followed by explaining several advanced quantum computing algorithms, including quantum error correction, sparse linear systems, and variational eigensolver. Google Cirq quantum programming library will be used for actual quantum programming implementations of the algorithms discussed. Prereq: ELEC 4678 or ELEC 3817 or CSI 3560 or CSI 4650 or CSI 4110 with a C- or higher or Permission of Instructor. Restriction: Restricted to students with graduate standing. Cross-listed with ELEC 4679, PHYS 4679, and PHYS 5679. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 4678 or ELEC 3817 or CSI 3560 or CSI 4650 or CSI 4110 with a C- or higher. Restriction: Restricted to students with graduate standing.
Typically Offered: Fall.

ELEC 5680 - Quantum Computing Technology (3 Credits)
Students will explore some of the concepts and experimental practices for realizing quantum computers. They will engage in laboratory practice of relevant skills including high-performance analog electronics; optics based quantum encryption and eraser implementations; RF electronics; and vacuum and cryogenic techniques. Prereq: ELEC 3900 with a C- or higher or Permission of Instructor. Restriction: Restricted to students with graduate standing. Cross-listed with ELEC 4680, PHYS 4680, and PHYS 5680. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ELEC 3900 with a C- or better or Graduate Standing.
Typically Offered: Fall.

ELEC 5681 - Quantum Technology Systems (3 Credits)
Students will explore a systems approach toward experimental practices for realizing quantum information science and engineering (QISE), with a focus on vacuum and cryogenic techniques and integration of electronics subsystems into a "dry" cryostat. They will engage in laboratory practice of relevant skills including creation and measurement of high vacuum, methods for reaching ultra-low temperatures, concerns in the design and construction of cryogenic apparatuses, and operation of a "dry" cryogenic system at 4 K, including measurements on superconducting quantum interference devices. Prereq: PHYS 4680 OR PHYS 5680 OR ELEC 4680 OR ELEC 5680 with a C- or higher or Permission of Instructor. Cross-listed with ELEC 681, PHYS 4681 and PHYS 5681. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: PHYS 4680 OR PHYS 5680 OR ELEC 4680 OR ELEC 5680 with a C- or higher.
ELEC 5697 - Optical and Spatial Information Processing (3 Credits)
Processing of two- and three-dimensional spatial information. The scalar diffraction theory necessary to describe the information-bearing wave-front. Wave-front recording, modulations, and reconstruction. Holography, Fourier transform properties of lenses, two-dimensional convolution and correlation, pattern recognition, and optical information processing. Prereq: ELEC 3316. Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5710 - Advanced Electric Drive Systems (3 Credits)
Covers advanced theory and implementation techniques for rotating electric machinery drives. Topics include field oriented control theory, detailed dynamic modeling of induction machine/drive system, advanced control algorithms and controller design. Prereq: ELEC 4164/5164 or equivalent. Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5714 - Energy Systems Analysis (3 Credits)
Transmission line constants, including details of GMD methods, skin effect. Analysis of balanced and unbalanced line using distributed parameters, energy flow from circle diagram approach, traveling-wave phenomena, corona, power cables and fundamentals of DC transmission. Prereq: ELEC 4184. Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5720 - Practical Electric Drive Systems (3 Credits)
Covers practical control theory and implementation techniques for electric machine drives for rotating electric machinery using high-performance hardware and software. Topics include machine theory review, power converter, control theory, controller design and actual implementation of an induction machine drive using up-to-date microcontroller hardware and software. Prereq: ELEC 2520, ELEC 4164/5164 or equivalent. Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5723 - High Performance Computer Architecture (3 Credits)
High Performance Computer Architecture covers the design of advanced computing systems. In particular, the course includes the design of modern microprocessors, characteristics of the memory hierarchy, and issues involved in multithreading and multicore architectures. Prereq: ELEC 3651 Digital Hardware Design. Cross-listed with ELEC 4723. Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5725 - Advanced Electric Machinery (3 Credits)
Covers theoretical principles and techniques of electric machine analysis focusing on rotating machinery. Topics include various machine definitions, properties and analysis, software tools, and examples. Prereq: ELEC 3164 or equivalent. Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5727 - Machine Vision Systems (3 Credits)
This course provides an introduction to machine vision systems regarding concepts, algorithms, and applications, especially revealing how the latest vision systems can mimic and even outperform humans in specific tasks. Through practical assignments and projects, students will learn to develop vision systems that can see, interpret, and act on visual data. Key topics include image/video formation and transformation, feature extraction, object recognition, and evaluating vision system performance. By the end of the course, students will have a solid background in machine vision algorithms and be able to advance their knowledge in solving real-world problems. Prereq: Requires prerequisite course of ELEC 3520 (minimum grade D-). Restriction: Restricted to graduate students only. Cross-listed with ELEC 4727. Term offered: Fall. Max hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5755 - Grid Integration of Renewable Energy (3 Credits)
This course focuses on the modeling, analysis and control of grid-connected wind and photovoltaic energy systems. Prereq: permission of instructor. Cross-listed with ELEC 4755. Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade

ELEC 5764 - Power Distribution Systems (3 Credits)
Use of per-unit methods to find transient voltage behavior of industrial power systems resulting from motor starting, spotwelders and similar stimuli. System and device responses due to series and shunt capacitors and problems of subharmonics and over-excitation on induction motors. Design of power distribution systems. Prereq: ELEC 4184. Max hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5774 - Power Systems Dynamics and Protection (3 Credits)
Topics to be covered include: power system dynamic fundamentals, various stability problems, such as angle, frequency and voltage stability; protection of power systems apparatus and protective relays coordination. Prereq: ELEC 4184/5184 or graduate standing. Max Hours: 3 Credits.
Grading Basis: Letter Grade

ELEC 5800 - Special Topics (1-3 Credits)
Intermediate courses of variable title and variable credit, usually offered once by guest lecturers. See current departmental notices for details. Repeatable. Max hours: 9 Credits.
Grading Basis: Letter Grade

ELEC 5802 - Special Topics (3 Credits)
Prereq: ELEC 3701 with a C- or higher for ELEC undergraduates, MATH 2830 or equivalent for non-majors or Graduate standing. Cross-listed with ELEC 4802. Repeatable. Max hours: 9 Credits.
Grading Basis: Letter Grade

ELEC 5910 - Special Topics (3 Credits)
Cross-listed with ELEC 4810. Max hours: 3 Credits.
Grading Basis: Letter Grade
ELEC 5840 - Independent Study: ELEC (1-6 Credits)
Offers the opportunity for independent, creative work. Prereq: Permission of instructor. Repeatable. Max Hours: 6 Credits.
Grading Basis: Letter Grade

ELEC 5939 - Internship Master Student (1-3 Credits)
Student will outline internship tasks every 2-3 weeks in a progress report. Reports will include the details of exposure to electrical/computer engineering concepts. Each concept will be described with respect to CU Denver Electrical Engineering degree program. Courses that were taken pre-internship that prepared student for successful understanding for the task requirements. In addition, preparations that would be helpful, will also be mentioned. Engineering training in design and software tools related to internship tasks will be clearly described. Final semester report will describe all experiences and include recommendations on how students might prepare to be successful for other common tasks. Requisite: Graduate students must have completed 6 credit hours with a cumulative GPA of 3.0. Repeatable. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 3.

Graduate students must have completed 6 credit hours with a cumulative GPA of 3.0.

ELEC 5980 - Statistical Quality Control (3 Credits)
Introduces statistical methods of quality control. Statistical process control, process capability, statistical design of experiments and total quality management. Prereq: Graduate standing or permission of instructor. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 3.

ELEC 6000 - Statistical Signal Processing (3 Credits)
The objective of this course is to present a systematic coverage of statistical signal processing methods which are fundamental for processing, identifying and classifying stochastically (randomly) generated data sequences. Emphasis will be given to methods which resist data outliers. Important applications include communications and biological systems. Prereq: ELEC 5617 or consent of instructor. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 3.

ELEC 6800 - Special Topics (1-3 Credits)
Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.

ELEC 6950 - Master's Thesis (1-8 Credits)
Repeatable. Max hours: 8 Credits.
Grading Basis: Letter Grade with IP
Repeatable. Max Credits: 8.
Additional Information: Report as Full Time.

ELEC 6960 - Master's Report (1-8 Credits)
Repeatable. Max hours: 8 Credits.
Grading Basis: Letter Grade with IP
Repeatable. Max Credits: 8.
Additional Information: Report as Full Time.

ELEC 7800 - Special Topics (1-3 Credits)
Courses of variable title and variable credit, usually offered once by guest lecturers. See current departmental notices for details. Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.

ELEC 7801 - Special Topics (1-3 Credits)
Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.

ELEC 7802 - Special Topics (1-3 Credits)
Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.

ELEC 7803 - Special Topics (1-3 Credits)
Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.

ELEC 7804 - Special Topics (1-3 Credits)
Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.

ELEC 7805 - Special Topics (1-3 Credits)
Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.

ELEC 7806 - Special Topics (1-3 Credits)
Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.

ELEC 7807 - Special Topics (1-3 Credits)
Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.

ELEC 7808 - Special Topics (1-3 Credits)
Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.

ELEC 7809 - Special Topics (1-3 Credits)
Repeatable. Max Hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.

ELEC 7840 - Independent Study: ELEC (1-6 Credits)
Offers the opportunity for independent, creative work. Prereq: Permission of instructor. Repeatable. Max Hours: 6 Credits.
Grading Basis: Letter Grade

ELEC 8990 - Doctoral Dissertation (1-10 Credits)
Repeatable. Max hours: 10 Credits.
Grading Basis: Letter Grade with IP
Repeatable. Max Credits: 10.
Additional Information: Report as Full Time.