ELECTRONICS (ELEC)

ELEC1100 CIRCUIT THEORY I
The concepts of current, voltage, power, energy, and resistance are studied. Topics include DC and AC sources, capacitance, inductance, and magnetism. Resistive circuits are analyzed using Ohm's and Kirchhoff's Laws and computer-aided circuit analysis using SPICE is included. ***Corequisite:*** *MATH1000 or MATH1035 (4 credits)*

ELEC1500 CIRCUIT THEORY II
The concepts of impedance and admittance in sinusoidal circuits are examined. Circuits are solved using superposition, Thevenin, Norton, nodal, and mesh analysis. Resonant circuits and transformer theory are also studied. Laboratory work and computer-aided analysis techniques are designed to correlate with theory. ***Prerequisite:*** *ELEC1100;* ***Corequisite:*** *MATH1500 (4 credits)*

ELEC2000 SEMICONDUCTOR DEVICES
A variety of semiconductor devices are introduced. Emphasis is placed on diodes, BJT, oscillators and FET. A variety of applications including triacs, SCRs, optoisolators, and other devices are also included. ***Prerequisite:*** *ELEC1500;* ***Corequisite:*** *MATH1700 (4 credits)*

ELEC2100 LOGIC CIRCUITS
This course introduces the Boolean algebra, combination logic circuits, counters, registers, ALUs, encoders, decoders and multiplexer. Circuit simulation software is used in laboratory work. ***Prerequisite:*** *ELEC1100 (4 credits)*

ELEC2250 NETWORK THEORY I
The fundamental concepts of current, voltage, and power are studied along with the properties of passive circuit elements as well as network theorems. Transient analysis R-L, R-C, and R-L-C circuits and initial conditions are studied. Laboratory experiments parallel classroom theory and include circuit simulation. ***Prerequisite:*** *MATH1877, MATH1850 or MATH1875 (4 credits)*

ELEC2275 DIGITAL LOGIC
This course introduces digital logic and circuits. Topics include continuous and discrete number representations, binary arithmetic, combinational logic (Boolean algebra, truth tables, Karnaugh maps, encoders, decoders, multiplexer), sequential logic (flip-flops, timing diagrams, counters, registers, state machines, memory), integrated circuit issues (operating characteristics, logic voltage levels, propagation delay, fan-out), power dissipation) and programmable logic devices. Digital circuits are implemented and tested utilizing both schematic diagram representation and hardware description language (HDL). (4 credits) fall, spring

ELEC2299 ELECTRICAL CIRCUIT ANALYSIS & DESIGN
Basic electric circuit theory is covered, including direct current (DC), transient, and alternating current (AC) steady state analysis. Specific topics include the concepts of current, voltage, resistance, capacitance, inductance, impedance, power, energy, power factor, Ohm's Law, series and parallel circuits, Kirchhoffs Laws, nodal analysis, mesh analysis, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Phasor diagrams, and introduction to the Laplace Transform in circuit analysis. Laboratory work and computer-aided analysis techniques are designed to correlate with circuit analysis theory and design. ***Corequisites:*** *MATH1850 or MATH1877 and PHYS1750 (4 credits) fall*

ELEC2300 CIRCUIT ANALYSIS
This course gives students an introduction to DC and AC circuit theorems, magnetic and transformer concepts, AC power, three phase balanced circuits, and Laplace Transform analysis. Transient analysis and initial conditions are studied for R-L, R-C, and R-L-C circuits. Laboratory experiments parallel classroom theory and include circuit simulation. ***Corequisite:*** *MATH2500 (4 credits) fall*

ELEC2499 LOGIC CIRCUITS
This course introduces binary and hexadecimal numbers, Boolean algebra, truth tables, Karnaugh maps, and combination logic using basic gates. Flip-flops, counters, registers, ALU's, encoders, and decoders are also presented. Circuit simulation software is used in both classroom and laboratory work. ***Prerequisite:*** *ELEC1100 (4 credits)*

ELEC2525 ELECTRICIAL FUNDAMENTALS FOR ROBOTICS
This course covers computational methods in kinematics and dynamics of spatial and planar robotic mechanisms. It introduces the analysis of positions, velocities, accelerations, actuating forces, and actuating torques, as well as industrial robot applications. Students gain hands-onexperience in simulating and implementing robotic arms and mechanisms with multiple degrees of freedom. ***Prerequisite:*** *MECH3850 (4 credits) fall*

ELEC2599 INTRODUCTION TO MICROPROCESSORS
This course introduces microprocessors and microcomputer systems. Related hardware and software issues will be covered. It will also cover memory systems, input/output devices, and interfacing mechanisms. ***Prerequisite:*** *ELEC2499 (4 credits)*

ELEC2600 DIGITAL APPLICATIONS
This course covers the analysis and modeling of high-speed digital systems. It examines the use of programmable CMOS integrated circuits. The student will learn to implement both combination and sequential logic circuits in addition finite state machines. ***Prerequisite:*** *ELEC1500 and ELEC2100;* ***Corequisite:*** *MATH1800 (4 credits)*

ELEC2699 INTEGRATED ELECTRONICS
This integrated electronics course covers basic analog and digital electronic circuits and devices. The topics include diodes, MOFSETs, FETs, BJTS, operational amplifiers, inverting, non-inverting, integrating, and differentiating op-amps, bioinstrumentation amplifiers, filters, oscillators and signal generators, digital logic, Boolean algebra, Karnaugh maps, logica gates, flip-flops, programmable logic devices, encoders, decoders, counters, registers and A to D converters. Lab experiments will include basic analog and digital devices, practical biomedical applications, and a design project. ***Prerequisite:*** *ELEC2299 (3 credits)*

ELEC2700 INTEGRATED CIRCUITS WITH APPLICATIONS
Integrated circuit applications of operational amplifiers and linear integrated circuits are introduced. Topics include the use of linear and non-linear IC's in open and closed loop (feedback) configurations. ***Prerequisite:*** *ELEC2000;* ***Corequisite:*** *MATH1800 (4 credits)*

ELEC2750 NETWORK THEORY II
In this continuation of Network Theory I, the concept of complex impedance and admittance is included. Circuits are analyzed using network theorems. Magnetic circuits, transformer concepts and AC power are studied in addition to three-phase balanced circuits. The Laplace Transform analysis and its application to circuit analysis are also studied. ***Prerequisites:*** *ELEC2250 and MATH2500 (4 credits)*

ELEC2799 CIRCUIT THEORY AND APPLICATION
Introduction to electrical and electronic circuits, with emphasis on building a foundation for applications involving mechanical systems. Voltage, current and power will be analyzed in DC and AC circuits having components that include resistors, capacitors, inductors, diodes or operational amplifiers. Some of the laboratory exercises will involve applications having sensors of mechanical phenomenon, signal conditioning , data acquisition and basic signal processing on a computer running suitable software. Some of the homework and laboratory exercises will involve building and testing circuits using circuit simulation software. ***Prerequisites:*** *MATH1750 and PHYS1750 (3 credits)*

ELEC2850 MICROCONTROLLERS USING C PROGRAMS
Students learn to develop both computer programs and microcontroller systems. Based on the C language, fundamental programming concepts are explored, including types, operators (Boolean, binary, numeric), expressions, control flow, functions, pointers, arrays, structures and input/output mechanisms. Microcontroller concepts are explored, including hardware architecture, programming model, timers, interrupts, data acquisition, signal output and serial communication. Peripheral circuits for microcontrollers are developed for signal conditioning of sensor input and for controlling of actuators. ***Prerequisite:*** *ELEC2275 (4 credits)*

ELEC2950 EMBEDDED COMPUTER SYSTEMS
Students will design embedded data acquisition systems to monitor and record data from a variety of electromechanical systems. This course includes the study and use of sensors for measurement of physical parameters, signal conditioning for input interfacing, semiconductor devices for output control. Both hardware and software designs are implemented to solve a variety of engineering applications. ***Prerequisite:*** *ELEC2275 (3 credits)*

ELEC3000 OBJECT ORIENTED PROGRAMMING ELECTRONICS
This course is an introduction to object oriented programming topics useful for electronics. Topics include I/O file streams and data files, introduction to classes, class functions, and conversions. ***Prerequisite:*** *ELEC2850 (4 credits)*

ELEC3025 INTERNET OF THINGS
This course explores technology and development for the internet of things (IoT), including the IoT aspects of 1) nodes of embedded processors connected to sensors or actuators, 2) communication between nodes, gateways and the cloud using communication protocols, and 3) cloud for data storage and analytics. ***Corequisite:*** *ELEC2250 or ELEC2299 or ELEC2799 or BIOE2500 or COMP1200 & PHYS1750. (4 credits)*

ELEC3050 INTRODUCTION TO RENEWABLE ENERGY
This course covers the fundamental principles of renewable energy and the basic energy analysis corresponding to power generation systems. It explores the principles, concepts, and applications of renewable energy for electrical power generation. The course also considers topics such as energy consumption, energy production, energy conversion, the national electric grid, biomass and biofuels, geothermal power, wind power, solar power, hydropower, and other new renewable energy sources. ***Prerequisites:*** *ELEC2250 or ELEC2799 or ELEC2299 or ELEC2300 (4 credits) fall*

ELEC3100 DATA COMMUNICATIONS
This course introduces the concepts of digital transmission, metallic cable and fiber transmission media, transmission lines, public telephone network and data communications. ***Prerequisite:*** *ELEC2100 (4 credits)*

ELEC3150 OBJECT ORIENTED PROGRAMMING FOR ENGINEERS
This course introduces students to a set of tools and methods that enables engineers to build reliable, user-friendly, maintainable, well documented, reusable software systems. This course teaches these fundamental ideas through the object-oriented approach to programming using C++ and Java. ***Prerequisite:*** *ELEC2850 (4 credits)*

ELEC3160 DIGITAL IMAGE PROCESSING
This covers the basic concepts and techniques of digital image processing. Topics include grayscale and binary processing, image Fourier analysis, image enhancement, and color image processing. Programming is integrated in laboratory exercises to demonstrate the implementation of image processing algorithms, as well as their effects on the spatial information. ***Corequisite:*** *ELEC3600 (4 credits)*

ELEC3200 ADVANCED DIGITAL CIRCUIT DESIGN
Students learn the approach to designing complex digital systems described using schematic entry or hardware description languages. Circuits are synthesized, simulated and tested on programmable logic hardware circuits. ***Prerequisite:*** *ELEC2275 (4 credits)*

ELEC3225 APPLIED PROGRAMMING CONCEPTS
This course will introduce engineers to applied programming concepts and large-scale programming projects. Topics include design patterns, data structures, database management, advanced user's interfaces, algorithm design, and version control and regression testing. The course will focus on hands-on programming, with both small and large projects. ***Prerequisites:*** *ELEC3150 or instructor permission (3 credits) summer*

ELEC3250 ANALOG CIRCUIT DESIGN
This course covers the concepts of design, analysis, simulation, implementation and evaluation of analog electronic circuits and systems. Topics include semiconductor physics, BJT, MOS, and FET devices and linear integrated circuits. ***Prerequisite:*** *ELEC2750 or ELEC2300 (4 credits) fall, spring*

ELEC3275 MICROCONTROLLER & COMMUNICATION
In this course, students learn to develop embedded systems based on microcontrollers and how to communicate to other devices, computers, and web services. The course covers microcontroller concepts, including hardware architecture, programming models, programming with the C language, timers, interrupts, data acquisition, signal output, and serial communication. Students develop peripheral circuits to interface with a microcontroller for signal conditioning and sensor input, as well as for controlling actuators. The course also has students utilize communication protocols to transmit and receive messages with a microcontroller. ***Prerequisites:*** *ELEC2275 or ELEC2525 or ELEC2699 or MATH2300 and ENGR2100 or COMP1000. (4 credits) spring*

ELEC3300 ELECTRIC MACHINES & TRANSFORMERS
This course concentrates on single-phase and three-phase systems, magnetic systems, transformers, electromechanical conversion principles, three-phase and single-phase induction motors, synchronous motors and generators, DC generators and motors, and stepper motors as applied to electric power and control systems. Laboratory work parallels classroom theory. ***Prerequisite:*** *ELEC1500 (4 credits)*

ELEC3350 SOLID STATE DEVICES
The primary goal of this course is to provide students with the essential background on semiconductor materials and devices including a basic understanding of crystal structure, energy bands, charge carriers and junctions. ***Prerequisites:*** *ELEC3250 and MATH2025 (3 credits)*

ELEC3430 POWER SYSTEMS ANALYSIS
This course provides a thorough study of the power system data necessary, and the methods commonly used in analysis of power systems. The types of studies covered may include: short circuit, symmetrical components and load flow, motor starting, cable ampacity, transient stability, harmonic analysis, switching transient, reliability protective relay coordination, power system modeling, transmission line parameters and representation, and economic load dispatch. ***Prerequisite:*** *ELEC1500 or ELEC2750 (3 credits)*

ELEC3450 MICROCONTROLLERS & EMBEDDED COMMUNICATION
This course will introduce the students to microcontroller principles, both hardware and software. Students will write assembly language programs using programming techniques and use sensor signal conditioning for interfacing and software design. ***Prerequisite:*** *ELEC2100 (4 credits)*

ELEC3500 ELECTRONICS II
This course, the second in a two-course sequence, covers the concepts of design, analysis, simulation, implementation and evaluation of electronic circuits and systems. Topics include diodes, MOSFETs, BJTs, building blocks of integrated circuit amplifiers, differential and multi-stage amplifiers, and output stages and power amplifiers. ***Prerequisites:*** *ELEC3350 (4 credits)*

ELEC3550 COMPUTER NETWORKS FOR ENGINEERS
This course focuses on the Internet and a modern treatment of computer networking. Topics include network services, application, transport and network layers, local area networks, wireless and mobile networks, multimedia networking and network security. ***Prerequisite:*** *ELEC3150 (4 credits) summer*

ELEC3575 COMPUTER COMMUNICATION & NETWORK
This course covers local (LAN), metropolitan (MAN) and wide area (WAN) networks, topologies and transmission media, network interface and management, congestion/flow/error control, routing and addressing. Laboratory exercises include simulation and installation of small network. ***Prerequisite:*** *ELEC3100 (4 credits)*

ELEC3600 SIGNALS AND SYSTEMS
This course introduces students to signals and systems and to linear algebra. Topics include: matrix operations, determinants, vector spaces, linear transformations, orthogonality, eigenvalues, signal operations, classifications of signals and systems, continuous-time LTI system analysis (impulse response, convolution, Laplace transform and its applications), continuous-time signal analysis (Fourier series, Fourier transform and its applications). ***Prerequisites:*** *MATH2025 and MATH2500 (4 credits)*

ELEC3650 EMBEDDED SENSOR NETWORK
This course focuses on the embedded processor nodes with sensors and actuators that are on the edge of the Internet of Things (IoT), interacting with the physical world. Theory and methods of IoT, microcontrollers, electronic interfaces, sensor input, actuator output, and communication to other embedded nodes, gateways and the cloud are investigated. Students develop systems by programming software and assembling hardware components for IoT applications. ***Corequisite:*** *COMP1000 or ELEC2850. (4 credits)*

ELEC3675 LINEAR NETWORK ANALYSIS
This course introduces first and second order differential equations, initial condition problems, Laplace Transforms with partial fraction expansion, pole/zero analysis, and Fourier Transforms. Associated laboratory experiments parallel the theory and help demonstrate the practical usefulness of the topics as they apply to electronic and computer engineering technology problems. ***Prerequisite:*** *MATH2000 (4 credits)*

ELEC3700 INTRODUCTION TO ROBOTICS
This course introduces basic concepts and applications of robotics. Topics include kinematics, inverse kinematics, sensors and actuators, control, planning, and localization. Real-world applications of robots and nonconventional robots are explored. The course includes laboratory exercises that allow students to develop programs and assemblies to work on robotic manipulators and wheeled robots. ***Prerequisite:*** *ELEC2250 or ELEC2299 or ELEC2799 and ELEC2850 or ENGR2100 or COMP1000 (3 credits)*

ELEC3725 COMPUTER ARCHITECTURE
This course introduces engineering students with the design of computer systems and components; processor design, instruction set design, and addressing; control structures and microprogramming; memory management, caches, and memory hierarchy; interrupts and I/O structures. ***Prerequisite:*** *ELEC2850 (3 credits) fall*

ELEC3750 COMPUTER SYSTEMS ARCHITECTURE
This course examines the operation of a computer system including microprocessor, I/O, mass storage, monitors, and memory. Introduces machine language and compilers as applied to current and state-of-the-art systems. Interfacing with stepper motors and sensors are also introduced. ***Prerequisite:*** *ELEC2100 (4 credits)*

ELEC3775 DISCRETE SIGNALS & SYSTEMS
Discrete signals and systems are identified and studied. The use of difference equations, convolution techniques, and z-transforms are included. The need for anti-aliasing filters, sample-and-hold circuitry as well as limitations of ADCs are emphasized. Laboratory exercises address practical solutions to problems. ***Prerequisite:*** *Junior status;* ***Corequisite:*** *ELEC3675 (4 credits)*

ELEC3800 SPECIAL TOPICS IN ELECTRONICS
Presents topics that are not covered by existing courses and are likely to change from semester to semester. Refer to the Class Schedule for a specific semester for details of offerings for the semester. (1 - 4 credits)

ELEC3900 INTRODUCTION TO NANOTECHNOLOGY
The ongoing impact of nanotechnology on the current state of science and engineering will be explored here. Various deposition techniques and applications are also studied. (3 credits)

ELEC3920 ENGINEERING SIGNALS & SYSTEMS
Continuous and discrete-time signals and systems will be studied. Time domain analysis of linear systems will include convolution (discrete and continuous), time-invariance, causality, and stability of systems. Time domain analysis of signals using the Fourier series and Fourier integral will be covered as well as frequency domain analysis of signals using the Fourier transform. Laplace transform analysis of linear systems including pole-zero plots and z-transform analysis of discrete systems will be studied. Laboratory exercises will use computer software to strengthen important course concepts. ***Prerequisites:*** *ELEC2750 and MATH2500 (4 credits)*

ELEC3950 ADVANCED SENSORS & INTERFACING SYSTEMS
Topics include linear and nonlinear sensors, high-performance instrumentation amplifiers for signal conditioning, temperature sensors, analog computational units with application of linear regression techniques, and design of multiplier circuits. Modern sensors and interfacing with microcontrollers are introduced. ***Prerequisite:*** *ELEC2700 (4 credits)*

ELEC4000 DIGITAL SIGNAL PROCESSING
This course presents the basic digital signal processing (DSP) principles used in the design and analysis of sampled signals. Topics include but are not limited to design of finite impulse response (FIR) filters and infinite impulse response (IIR) filters. The Fast Fourier Transform (FFT) is studied in order to compute the Discrete Fourier Transform (DFT). Laboratory experiments emphasize hardware and software solutions to practical problems. ***Prerequisites:*** *ELEC3775 (4 credits)*

ELEC4025 HARDWARE SECURITY
This course will introduce students to the hardware and related software aspects of modern computing devices. Students will learn about confidentiality, data integrity, availability, general methods of data/information protection, and study existing exploitations, in order to design more security systems/devices. Students will also study the ethics of hacking and security. ***Prerequisites:*** *ELEC2850 or instructor permission (3 credits) summer*

ELEC4050 MOTORS AND CONTROLS
This course reviews the topic of magnetic, DC, AC (single and 3-phase) and special motors are considered. Applications of different types of motors will be discussed. Electromechanical control equipment as well as the solid state control equipment will be covered. The course will use the knowledge learned in previous courses in the curriculum to build a working model for a particular application. ***Prerequisites:*** *ELEC3250 and MATH2025 (4 credits)*

ELEC4075 ENGINEERING OPERATING SYSTEMS
Students will learn the fundamentals of operating systems concepts and architectures for various platforms such as personal computers, mobile, networked and real-time embedded systems. Coverage shall include operating systems architecture, concepts and methods for managing processes and threads, main memory, file systems, I/O management and real-time systems. Detailed examples are taken from several operating systems, emphasizing the techniques used in UNIX variants. Concepts and techniques will be demonstrated using lab experiments using UNIX-like system such as Linux or QNX. ***Prerequisite:*** *ELEC3150 (4 credits) spring*

ELEC4100 ELECTROMAGNETICS
Static electric and magnetic fields are studied in this course. Maxwell's equations are presented and time-varying fields are introduced. Laboratory applications include transmission of electromagnetic waves in air and on transmission lines. ***Prerequisite:*** *MATH2000 (4 credits)*

ELEC4200 DIGITAL CONTROL & SYSTEMS
This course will use velocity and position feedback to control servos. PID and other types of systems will be analyzed through software packages employing BODE, Nyquist and Root locus techniques. ***Prerequisite:*** *ELEC3675;* ***Corequisite:*** *ELEC4225 (4 credits)*

ELEC4225 INTRODUCTION TO DIGITAL SIGNAL PROCESS
This course introduces sampling, aliasing, ADCs and z-transforms. DSP applications including digital filtering (both FIR and IIR) are analyzed and designed. Fast Fourier Transform (FFT) is studied in order to compute the Discrete Fourier Transform (DFT). Laboratory experiments emphasize hardware and software solutions to practical problems. ***Prerequisites:*** *ELEC3450 and ELEC3675 (4 credits)*

ELEC4300 ENGINEERING COMMUNICATION SYSTEMS
This course serves as an introductory course in analog and digital communication systems. Topics covered include amplitude, frequency, pulse and pulse-code modulation and signal-to-noise ratios for various modulation schemes and sampling, quantization and coding. The laboratory would augment the course materials. ***Prerequisite:*** *MATH2100 (4 credits)*

ELEC4350 FEEDBACK CONTROL SYSTEMS
Analysis and design of linear control systems will be accomplished using Root locus, Bode and Nyquist techniques. The laboratory experiments will include servo trainers and employing 4 software packages. Digital systems will be introduced as well as state variables. PID controllers will be covered. ***Prerequisites:*** *ELEC3675 and ELEC3775 (4 credits)*

ELEC4400 ENGINEERING DIGITAL SIGNAL PROCESSING
This course presents the theory and practice of digital signal processing. Topics include review of discrete-time signals, systems and the Z-transform; sampling and quantization; Fourier transforms (DTFT, DFT and FFT) with applications to fast convolution; design techniques for FIR and IIR digital filters; realization structures for digital filters and finite precision effects; fundamentals of multirate signal processing and filter-banks; and DSP applications. ***Prerequisites:*** *ELEC3600 and MATH2300 (4 credits)*

ELEC4425 ADVANCED PROGRAMMABLE LOGIC
The objective of this course is to build a RISC processor core. The emphasis will be on implementing MSI circuits using VHDL language. Students utilize top-down methodology to design complex logic circuits using programmable logic abstractions. They synthesize hierarchical architecture structures in building a processor core. ***Prerequisites:*** *ELEC2100 and ELEC3750 (3 credits)*

ELEC4450 DIGITAL COMMUNICATION SYSTEMS
This course studies sampling, coding, decoding, pulse code modulation, digital multiplexing, digital carrier systems, frequency shift keying, data compression, as well as bandwidth considerations. Laboratory work parallels classroom theory. ***Prerequisite:*** *ELEC3775 or ELEC4425 (4 credits)*

ELEC4475 FEEDBACK AND CONTROL
The definition of an analog feedback control system will be the introduction of the course. The course proceeds with the time-domain and frequency-domain analysis of closed loop feedback control systems. The relationship between the time-domain and frequency-domain is discussed. The stability methods are explained. The course provides an introduction to the state-space method and an introduction to discrete control systems. ***Prerequisites:*** *MATH2500 and ELEC3250 (4 credits) summer*

ELEC4500 ELECTRONICS DESIGN PROJECT I
The first of a two course sequence, this course concentrates on the selection of an appropriate engineering project for design, the development of time and financial budgets, and milestone graphs. The majority of work is spent in the laboratory researching, designing, prototyping, debugging, and acquiring data on the students' individual designs. Engineering notebook is required. ***Prerequisites:*** *ELEC3450 and ELEC3950; senior status (3 credits)*

ELEC4725 ADVANCED COMPUTER ARCHITECTURE
We will discuss various concepts behind the designs of current microprocessors. In particular, the topics that will be covered in the course are but not limited to: performance simulators and evaluation, static and dynamic scheduling, instruction-level parallelism, advanced pipelining, speculative execution, memory hierarchy and organization, multi-processing. This course is cross-listed with ELEC6325 ***Prerequisite:*** *ELEC3725 (3 credits) spring*

ELEC5000 SENIOR DESIGN PROJECT I
This course is for BCOT senior students to pursue project-oriented work. Students may work in their curriculum or become involved in an interdisciplinary problem. Course requirements include oral and written progress reports throughout the semester plus a final technical report documenting the semester's work. ***Prerequisite:*** *Senior status (4 credits)*

ELEC5500 SENIOR DESIGN PROJECT II
The second of a two course sequence, Senior Design Project II focuses on implementing the design developed in Senior Design Project I. Emphasis is placed on both oral and written presentation skills as well as packaging and fabrication of an "engineering prototype". ***Prerequisites:*** *ELEC4500 (3 credits)*

ELEC5510 FOUNDATIONS OF ELECTRICAL CIRCUITS
This course is an accelerated introduction to DC and AC electrical circuit analysis and measurement techniques. It establishes a foundation in electrical circuits, serving as a transition for interdisciplinary graduate students toward applications of electrical engineering. The concepts of voltage, current, power, resistance, capacitance and inductance are investigated. DC and AC circuit-analysis techniques are covered such as Kirchhoff's Laws, nodal and mesh analysis, and Thevenin's and Norton's theorems. In addition, students will investigate steady state sinusoidal analysis, AC power, three phase balanced circuits and transformers. The expected background of the students would include knowledge of physics and calculus related to electrical and magnetic phenomena.(3 credits)

ELEC5520 FOUNDATIONS IN SIGNALS AND SYSTEMS
This course serves as an accelerated review of the fundamentals of electrical engineering concepts. Topics include analysis of AC circuits using phasors, linear algebra, analysis of linear time invariant (LTI) systems, impulse and step response, convolution, and Laplace, Z and Fourier transforms. Applications of signals and systems in communication and feedback and control will be explored. The expected background for students includes knowledge of calculus and differential equations. (3 credits)

ELEC5540 SMART BUILDINGS
This course explores the application of Internet of things (IoT) to homes, buildings and campuses. Ways to monitor, analyze and control actuators in buildings are investigated. Methods and rationale are studied for communication of building-related data with cloud servers for storage, analytics, and communication of status and alerts with stakeholders. Beneficial functions of smart buildings will be discussed with relation to energy efficiency, utilization of resources, responsiveness, and security. Students will utilize protocols, programming languages and technology for smart building applications. Students will investigate case studies related to smart buildings and present their findings to the class. (3 credits)

ELEC5550 DIGITAL SIGNAL PROCESSING
This course presents the theory and practice of digital signal processing (DSP). Topics include discrete-time signals and systems and the Z-transform, analog to digital conversion (A/D), sampling and quantization, discrete-time Fourier transforms (DTFT) and design techniques for finite impulse response (FIR) and infinite impulse response (IIR) digital filters. DSP applications using a programming language will be explored in applications such as audio processing and telecommunication. The expected background of students includes knowledge of signals and systems.(3 credits)

ELEC5560 POWER SYSTEMS ANALYSIS I
This course explores power systems architecture and its modeling parameters. The course covers the operation analysis of power systems under balanced conditions. Topics of study include overview of power and per unit (PU) system, network matrices and solutions, formulation of power flow and solution methods, automatic generation control (AGC) and new energy markets, and system stability. The expected background of the students is knowledge of AC circuits. This course is cross-listed with ELEC3430 (3 credits)

ELEC5650 EMBEDDED SYSTEMS
This course covers topics in hardware and software co-design for embedded systems, high-level synthesis, and system-level modeling and integration. The course will employ advanced methods of digital circuit design, specification, and synthesis, using computer aided design (CAD) tools for implementation of complex digital systems on field programmable gate arrays (FPGAs) and systems on chip (SoC). The expected background for students includes knowledge in low-level programming of microcontrollers and digital circuit design using a hardware description language. (3 credits)

ELEC5660 POWER SYSTEMS ANALYSIS II
This course explores the performance of power systems, including methods to analyze, collect, and manage data. The theory and analysis of performance for balanced power systems are first reviewed, and then extended to include cases of unbalanced power systems. Topics of study include transmission line parameters, symmetrical components, fault analysis, stability, transient and harmonic analysis, protection, and power quality. ***Prerequisite:*** *ELEC5560 (3 credits)*

ELEC5675 VLSI
Students learn design methodologies for very large-scale integration (VLSI) circuits. The design and layout of complementary metal-oxide-semiconductor (CMOS) VLSI circuits are a primary focus, with particular emphasis on how these design decisions affect area, performance, power consumption, and reliability of a circuit. Circuit and devices characteristics are discussed. Various design techniques are presented in class. Students will develop and analyze various custom integrated circuit (IC) implementations by using appropriate electronic design automation (EDA) tools. The expected background for students includes knowledge in logic design, circuit theory, and basic computer programming. (3 credits)

ELEC5700 ROBOTICS & AUTOMATION SYSTEMS
This course presents an overview of robotic and automated systems, focusing on state-of-the art industry practices and future research directions. Topics include robot operating systems, sensor fusion, feedback control, localization and mapping, path and motion planning, robot-robot and human-robot interaction, and autonomous operation. Students will engage in hands-on laboratory exercises and independent and project-based learning implemented via simulations and modern robotic platforms. The expected background for students includes programming knowledge using a high-level language, as well as some experience in electronic interfacing. (3 credits)

ELEC5725 MACHINE PERCEPTION & COGNITION
This course introduces pattern classification methods to both analyze and characterize engineering problems. Students are introduced to feature extraction, linear discriminates, decision theory, nonparametric techniques, and unsupervised learning and clustering. The expected background of the students includes knowledge of probability and statistics.(3 credits)

ELEC5750 INDUSTRIAL CONTROLS
This course covers the concepts, devices, and common practices associated with control systems, with a primary focus on industrial applications. The course explores the hierarchical implementation of industrial control theory. Students will acquire knowledge and develop skills related to programmable logic controllers (PLC), which serve in many industrial applications as the primary edge note for sensors, actuators and communication. Electrical industrial engineering and safety standards are presented throughout the course. The expected background for students includes knowledge of feedback and control systems. (3 credits)

ELEC5825 ELECTRICAL BUILDING SYSTEMS
The fundamental knowledge needed to carry out design calculations for building electrical systems are covered. The concepts discussed and applied include electrical transformers and motors, protection devices, types and sizes of conductors and conduits, fire alarms, and communication methods. General procedures are covered for designing electrical systems based on the National Electrical Code (NEC) requirements and energy efficiency measures specific to electrical equipment and loads. The expected background of students includes knowledge of basic electrical circuit analysis, AC signals, phasors and complex numbers. (3 credits)

ELEC5850 ENGINEERING NUMERICAL METHODS
This course introduces concepts in the area of numerical methods for solving engineering problems. Students are introduced to numerical differentiation and integration, interpolation and extrapolation of polynomials, numerical regression and correlation, solving for roots of equations, linear algebraic equations, solutions of simultaneous equations, and numerical solution of partial differential equations. The expected background of students is knowledge of mathematics used in engineering and basic programming techniques. (3 credits)

ELEC5875 ADVANCED COMPUTER ARCHITECTURE
We will discuss various concepts behind the designs of modern microprocessors. In particular, the topics that will be covered in the course are: performance simulators and evaluation, static and dynamic scheduling, parallelism, speculative execution, memory hierarchy and organization, multi-processing. Additional advanced topics will include domain-specific architectures, abstract-level microprocessor security, and other cutting-edge topics. Students will also do a paper study in a research topic. The expected background of students is knowledge of instruction set architecture and in-order pipelines. This course is cross-listed with ELEC4725. (3 credits)

ELEC5900 INTRODUCTION TO RADAR SYSTEMS
This course explores the fundamentals of radar systems and modern radar implementations. Topics of study include radar concepts, applications, and design issues. Simulation tools are used to solve radar detection problems. The expected background for students includes knowledge of electromagnetic field theory and of signals and systems. (3 credits)

ELEC5925 INTRODUCTION TO MICROWAVE IMAGING
This course explores microwave imaging algorithms and systems. Topics of study include antennas, radar, and signal processing, as well as 1-D/2-D image generation of targets in both free space and hidden behind walls. The expected background for students includes knowledge of electromagnetic field theory and of signals and systems. (3 credits)

ELEC5950 ANTENNA THEORY
This course explores antenna theory, simulation, and design. The course covers Maxwell's equations and the corresponding concepts of antenna analysis and design. Topics of study include parameters of transmitting and receiving antennas and types of antennas, such as dipole antenna, loop antenna, helical antenna, Yagi-Uda antenna, travelling wave antenna, and patch antenna. The expected background for students includes knowledge of electromagnetic field theory. (3 credits)

ELEC5975 PARALLEL COMPUTER ARCHITECTURE
This course will introduce the fundamental principles and practices in both parallel architecture and parallel computing. This course will also examine the challenges of parallel hardware design, parallel software design, and the interaction of hardware and software, where the emphasis will be the co-design of hardware and software to optimize parallelism. Topics to be covered include message-passing and shared-memory parallel programming paradigms, parallel programming, shared-memory and distributed memory architectures, scalability challenges, and interconnection networks for parallel computer architectures. The expected background of the students includes knowledge of computer architecture. (3 credits)

ELEC6125 RENEWABLE ENERGY INTEGRATION
This course covers issues involved with integrating variable renewable energy technologies into the electric power grid. The structure and function of the grid are discussed for cases of conventional sources, and for cases of additional renewable sources. Investigations are made into renewable electrical generation technologies and resource characteristics. Models are analyzed and developed for renewable energy systems, including demand response, peak load saving, load forecasting, and capacity credits for wind and solar generation. The expected background of the students includes electrical power systems analysis and basic knowledge of renewable energy. (3 credits)

ELEC6200 CYBER-PHYSICAL SYSTEMS
This course introduces students to concepts in modeling and analysis of cyber-physical systems. Topics include the analysis of both continuous- and discrete-time systems in the areas of control, signal processing, finite state machines, state-flow, embedded systems, model integration, verification and numerical simulation. Considerations are also made of mobility, security and computing challenges for cyber-physical systems. The expected background of the students includes embedded systems and feedback and control systems. ***Prerequisite:*** *ELEC5700 (3 credits)*

ELEC6300 MICROWAVE ENGINEERING
This course explores basic techniques for designing and analyzing passive devices that operate at high frequencies, for which distributed circuit effects must be considered. Maxwell's equations are applied to microwave circuits for analysis and design. Topics of study include transmission lines, network theory, waveguides, microwave filters, and electromagnetic compatibility. ***Prerequisite:*** *ELEC5925 (3 credits)*

ELEC7800 GRADUTE SPECIAL TOPICS IN ELECTRICAL ENGINEERING
Presents topics that are not covered by existing courses and are likely to change from semester to semester. Refer to the Class Schedule for a specific semester for details of special topics course offerings. (4 credits)