Academic and Curriculum Policies

Technical Electives - These credit hours are included in the curriculum with the intent to enhance the technical skills and knowledge of the student. Students may choose to select technical electives in a single area of electrical or computer engineering to advance their understanding of a particular area or technology, or they may choose to take coursework in a diversity of technical areas to give both breadth and depth to more than one area of interest.

Courses that are considered professional development in content are not accepted as technical electives. For professional development in areas of business or management, the Engineering Leadership minor or a business minor should be considered.

Restrictions on technical electives -

- Any UCF Department of ECE scheduled course listed as EEE/EEL 4000-4899 and EEL 4932 not already a required course for the degree program is an accepted technical elective. Please note that in all cases the prerequisites for any of these courses must be satisfied before enrolling in the course. In addition, EEE/EEL 5000-5899 (some CS Department courses for CpE students at the end of the list), including **EEL 5937** and BME 5572 courses may be used as technical electives, but students must have a major grade point average **AND** a UCF grade point average of at least 3.00 at the time the student registers for the course, a grade no lower than B in the prerequisite(s), and exceptional grades in the major courses. An override is required for all 5000-level courses. Use this link for override requests: Overrides – CECS Academic Affairs (ucf.edu). No courses at the 3000 level will be accepted as technical electives unless specifically identified as an approved technical elective.

- The above also allows for courses that are required for other degree programs. For example, electrical engineering students are required to take EEE 4309C and EEL 4742C as required coursework, and computer engineering students are required to take EEL 4742C and EEL 4768 as required coursework. Therefore, EEL 4768 would be an accepted technical elective for electrical engineering students, while EEE 4309C would be an accepted technical elective for computer engineering students. Please note that in all cases the prerequisites for any of these courses must be satisfied prior to enrolling in the course.

- For the Computer Engineering Program approved technical electives include courses listed below with a prefix of CAP, CDA, COP, and COT, at the 4000-4899 (including 4932), and 5000-5899 level. Courses that require the CS Foundation Exam (COT 3960) may be used. Please see the CS academic advisor for an override to register for the course if needed. **In addition, Computer Engineering Program students may take no more than one course with a prefix of CNT (approved: CNT 4403, 4714, 5008). CpE students may not take any CEN courses, except CEN 5016.**

- Two new courses for CpE/EE students, EGN 4630/5640 or EGN 4641. **ECE will not accept both.**

- Additional College of Optics courses for EE students: OSE 4052, 4410 and OSE 4520

- Added starting Fall 2026: EMA 4411.

- Honors in the Major students may use EEL 4970H as a technical elective. CpE students have the option of using the CS honors version, but not both.

- EGN 4941 internship course, for 3 credits, **one time ONLY**.

- Students who need only one technical elective hour to complete their degree requirements and have a major grade point average AND a UCF grade point average of at least 3.00 at the time the student registers are allowed to enroll in **one hour** of independent study or independent directed research upon completion of the required agreement between the student and the faculty offering the independent study or independent research. Only Department of ECE faculty are permitted to supervise independent study or independent directed research hours which are to be accepted as technical electives. There are some CS Department faculty acceptable for CpE students. https://advising.cecs.ucf.edu/overrides/

- Courses that are from the College of Sciences or other UCF Colleges or departments are not accepted as technical electives. However, if a student has the desire to pursue additional coursework in an area such as mathematics or physics, a minor should be considered.

- Credit awarded for military, commercial, or private training will not be accepted as technical elective hours. No technical elective credit is accepted for experiential learning or cooperative education.

EE1: Power and Renewable Energy Track
EE2: Communications and Signal Processing Track
EE3: RF and Microwaves Track
CpE1: Digital VLSI Circuits Track

Program	Course
EE, CpE	BME 5572 ECS-EECS 3(3,0) Biomedical Nanotechnology: PR: EEL 3123C with a "C" (2.0) or better grade. Human Physiology, Bioelectric Phenomena and Neurons, Nanoelectronics for fabrication of biochips for human biomedical applications, self-assembly, bioelectronics, moral and ethical issues.
EE, CpE	CAI 4105 3(3,0) Current Topics in Machine Learning I: PR: EEL 3801C with a grade of "C" (2.0) or better; COP 3503C with a grade of "C" (2.0) or better; STA 3032 or EEL 3021. Machine Learning and Applications. Perception Network, BP Network, Convolutional NN, Recurrent NN, Evolutionary Computation, and Reinforcement Learning.
EE, CpE	CAI 4214 3(3,0) Current Topics in Machine Learning II: PR: Take or concurrently EEL 3021, EEL 4810, MAS 3105. Deep reinforcement learning integrates neural networks with decision-making algorithms to solve complex problems. Students will learn to develop theoretical understanding, implement algorithms, and apply DRL techniques to robotics, game playing, and autonomous systems through projects in this course.
EE1 EE2 CpE	EEE 4309C ECS-EECS 4(3,3) Electronics II: PR: EEE 3307C. Ideal Op-Amps and applications. Introduction to Logic Circuits; Bipolar, MOS and CMOS families; Flip-flops and memory cells, comparators and timing circuits: A/D and D/A converters. M&S fee $20.00.
EE	EEE 4314 ECS-EECS 3(3,0) Device Electronics for Integrated Circuits: PR: EEE 3350. P.N. Junctions, Bipolar Transistor Analysis, Metal Semiconductor contacts, MOS Systems MOSFET Analysis and Limitations.
EE, CpE	EEE 4334 - Introduction to VLSI Design: PR: Grade of "C" (2.0) or better in both EEE 3307C and EEE 3342C. CMOS technology, circuit design principles, modern fabrication techniques, MOS transistors, logic design, physical layout, timing analysis, low-power design techniques. EEE4334 or EEE5336 not both
EE, CpE	EEE 4346C ECS-EECS 3(2,3) Hardware Security and Trusted Circuit Design: PR: EEL 3801C with a grade of "C" (2.0) or better. Design, analysis and synthesis of sequential logic circuits and systems. Data path and controller design using a hardware descriptive language. Case studies on hardware security.
EE, CpE	EEE 4396C Introduction to Semiconductor Manufacturing: PR: EEL3004C or EGN3373 with a grade of "C" (2.0) or better. Introduces principles, processes, and equipment used in modern semiconductor fabrication. Wafer processing steps, design/fabrication of semiconductor devices, complete device fabrication, industry-relevant tools, measurement techniques.
EE	EEE 4463 ECS-EECS 3(3,0) MEMS Devices and Applications: PR: EEE 3350 or C.I. Micro-Electro Mechanical Systems devices, microfabrication, sensors and actuators, bulk and surface micromachining, optical MEMS, instrumentation and applications.
EE, CpE	EEE 4701 – Verification and Validation of Digital Systems PR: EEL 3801C with a grade of "C" (2.0) or better. Verification of digital hardware systems at the Register-Transfer Level focusing on Constrained Random Verification and the use of Universal Verification Methodology. EEE4701 or EEE5703 not both
EE, CpE	EEE 4775 - Real-Time Systems PR: COP 4600 or EEL 4768 or EEL 4742C. Introduction to specification, analysis, design, and validation techniques for real-time (operating) systems with an emphasis on real-time scheduling theory. EEE4775 or EEL5862 not both
EE	EEE 5265 ECS-EECS 3(3,0) Biomedical Effects and Applications of Electromagnetic Energy: PR: EEL 3470 or C.I. RF and microwave energy and their interaction with biological materials. Specific biomedical effects such as absorption, thermal therapy, hyperthermia, etc., will be discussed.
EE	EEE 5279 ECS-ECE 3(3,0) Advanced Bioelectronics Systems: PR: EEE 4309C or C.I. Advanced bioelectronics systems and techniques that enable recent biophysical and biomedical research will be discussed.
EE	EEE 5323 Radio Frequency Integrated Circuit Design: PR: EEE 3307C and EEL 3470 This course introduces the principles, analysis, and design of Radio frequency (RF) integrated circuits for wireless communication systems.

PROGRAM	Course
EE	EEE 5332C ECS-EECS 3(2,3) Thin Film Technology: PR: EEE 3350 or equivalent. Presents the various thin film deposition techniques for the fabrication of microelectronic, semiconductor, and optical devices. M&S fee: $70.00
CpE	EEE 5336 Introduction to VLSI Design: PR: EEE3307C and EEE 3342C. An introductory exploration of Very Large-Scale Integration (VLSI) design, focusing on CMOS technology, circuit design principles, and modern fabrication techniques. Students will learn the fundamentals of MOS transistors, logic design, physical layout, timing analysis, and low-power design techniques. The course will cover circuit simulation, design methodologies, and hands-on implementation of digital circuits, culminating in a practical design project. This class is ideal for students interested in semiconductor design, chip fabrication, and advanced digital systems. EEE4334 or EEE5336 not both
EE	EEE 5352 ECS-EECS 3(3,0) Semiconductor Material and Device Characterization: PR: EEE 3350 or C.I. Semiconductor material characterization resistivity, mobility, doping carrier lifetime, device properties, threshold voltage, interface charge of MOS devices, optical and surface characterization of films.
EE, CpE	EEE 5353 ECS-EECS 3(3,0) Semiconductor Device Modeling and Simulation: PR: EEE 3307C. Large signal and small signal model development for semiconductor diodes, BJTs, and MOSFETs. Parameter extraction, numerical algorithm, and SPICE simulation are included.
EE	EEE 5356C ECS-EECS 4(3,3) Fabrication of Solid-State Devices: PR: EEE 3350. Fabrication of microelectronic devices, processing technology, ion implantation and diffusion, device design, and layout. Laboratory includes device processing technology. M&S fee: $70.00
EE, CpE	EEE 5370 ECS-EECS 3(3,0) Operational Amplifiers: PR: EEE 4309C. Ideal and non-ideal Op-Amps. Linear applications. Active RC and switched-capacitor filters. Non-linear and other functional circuits. Frequency stability and compensation of Op-Amps.
EE	EEE 5378 ECS-EECS 3(3,0) CMOS Analog and Digital Circuit Design: PR: EEE 4309C. Advanced principles and design techniques for CMOS ICs including most recent published results.
EE, CpE	EEE 5390C ECS-EECS 3(2,3) Full-Custom VLSI Design: PR: EEE 3307C and EEE 3342C with a "C" (2.0) or better grade. Provide background in integrated devices, circuits, and digital subsystems needed for design and implementation of silicon logic chips.
EE, CpE	EEE 5513 ECS-EECS 3(3,0) Digital Signal Processing Applications: PR: EEL 4750. The design and practical consideration for implementing Digital Signal Processing Algorithms including Fast Fourier Transform techniques, and some useful applications.
EE	EEE 5416 Radiation Effects and Reliability in Microelectronics: CR: EEE3307C, or EEE3350, EEE3342C, or EEE4314, or EEE4309C. Radiation effects and long-term reliability of electronics; characterization and qualification for space. Modeling and simulation of basic mechanisms will be a recurring theme.
EE	EEE 5542 ECS-EECS 3(3,0) Random Processes I: PR: EEL 3552C and STA 3032. Elements of probability theory, random variables, and stochastic processes.
EE	EEE 5555 ECS-EECS 3(3,0) Surface Acoustic Wave Devices and Systems: PR: EEL 3552C. Course discusses SAW technology which includes the physical phenomenon, transducer design and synthesis, filter design and performance parameters. Actual devices and communication systems are presented.
EE, CpE	EEE 5557 ECS-EECS 3(3,0) Introduction to Radar Systems: PR: EEL 3552C. Introduction to Pulse and CW Radar Systems. Chirp Radar Systems. Tracking Radar. Noise in Radar Systems.
EE, CpE	EEE 5703 – Verification and Validation of Digital Systems PR: EEL 3801C or EEL 4742C both with a "C" (2.0) or better grade. Advanced Verification of digital hardware systems at the Register-Transfer Level exploring theory and practice for random verification and common object-oriented methodologies. EEE4701 or EEE5703 not both
EE, CpE	EEE 5781 - Cyber-Physical Technologies for Smart Communities: Prerequisite(s): Graduate Standing, EEL 4781 or EEL4515C or C.I. Introducing technologies that enable smart and connected communities; technologies include sensing, computing, communications, and device technologies related to smart grid, smart infrastructure, and intelligent transportation systems.
CpE	EEE 5790 - Introduction to Secure Architectures: Prerequisite(s): EEL 4768. This course will provide the students with basic understanding of the state-of-the-art support for implementing security primitives in commodity processors. Specifically, the course focus on Intel's Safe-Guard Extension(SGX), ARM's TrustZone and AMD's SME and SEV.

Program	Course
CpE	EEL 3552C ECS-EECS 4(3,3) Signal Analysis and Analog Communication: PR: EEL 3123C with a grade of "C" (2.0) or better. Signals and signal space, Signals and signal space, Fourier series, Fourier Integral, transmission over linear systems, AM, FM, PM, sampling theorem and Nyquist rate. M&S fee $15.00
CpE	EEL 3657 ECS-EECS 3(3,0) Linear Control Systems: PR: EEL 3123C with a grade of "C" (2.0) or better. Control theory, transfer function modeling, Nyquist criteria, root locus, Bode plots, and Design of lead and lag compensation.
EE, CpE	EEL 4140C ECS-EECS 4(3,3) Analog Filter Design: PR: EEL 3123C with a grade of "C" (2.0) or better. Passive and active analog filter design. M&S fee $15.00
EE, CpE	EEL 4205 ECS-EECS 3(3,0) Electric Machinery: PR: EEL 3004C with a grade of "C" (2.0) or better Fundamentals of DC and AC electric machines.
EE	EEL 4213 – Introduction to Power System Protection and Control: PR: EEL 3004C with a grade of "C" (2.0) or better and EEL4216 completed or concurrently. Complementary to the fundamentals of power systems engineering course that covers system operation under transient and fault conditions. Equip students with the basic knowledge of power systems under these conditions and prepare them for power engineering jobs and advanced study in the field.
EE, CpE	EEL 4216 ECS-EECS 3(3,0) Fundamentals of Electric Power Systems: PR: EEL 3004C with a grade of "C" (2.0) or better. Three-phase power representation and analysis, transformers, per unit system, symmetrical components, faults, and transmission lines.
EE, CpE	EEL 4298 - Power System Economics. Prerequisite(s): EEL 3004C The course examines fundamentals of power system economics, including power market operations and power system planning.
EE	EEL 4294 ECS-ECE 3(3,0) Introduction to Smart Grid: PR: (EEE 3307C and EEL 3657) or EEL 4216 or C.I. Fundamentals of electric power systems, distributed generation and smart grid components, voltage control and VAR compensation, demand response, leader-follower optimization, resiliency.
EE, CpE	EEL 4362 ECS-ECE 3(3,0) Post-CMOS Devices and Circuits: PR: EEE 3342C with a grade of "C" (2.0) or better and EEE 3307C.Post-CMOS device technologies for next-generation energy efficient memory and logic designs.
EE	EEL 4436C ECS-EECS 4(3,3) Microwave Engineering: PR: EEL 3470. Transmission line theory, Smith charts, S-parameters, simple impedance matching circuits, wave guides, resonators, basic microwave measurements. May be repeated for credit. M&S fee: $35.00 EEL4436C or EEL5437C not both
EE	EEL 4440C Optical Engineering: PR: MAC 2313 and (PHY 2049C or PHY 2049 or PHY 2049L) with a "C" (2.0) or better grade. Introduction to wave and photon models of light. Polarization and coherence. Interference and diffraction of light. Interferometers and spectrometers.
EE, CpE	EEL 4515C ECS-ECE 4(3,3) Fundamentals of Digital Communication: PR: EEL 3552C. Sampling and aliasing, quantization, PCM, delta modulation, line coding, intersymbol interference, Digital carrier systems, ASK, FSK, PSK, M-ary communication, Noise, BER analysis. M&S fee $20.00
EE, CpE	EEL 4518 ECS-EECS 3(3,0) Satellite Communications: PR: EEL 3552C. The principles of satellite communications, including communications satellites, Earth stations, link analysis, FDMA and TDMA. May be repeated for credit.
EE, CpE	EEL 4612C ECS-EECS 4(3,3) Introduction to Modern and Robust Control: PR: EEL 3657. Classical control theory including differential equations and Laplace transform techniques, stability analysis, and classical frequency domain design. Modeling and Position, Speed, Vibration Control Design Laboratories.
EE, CpE	EEL 4635C CECS-EECS 4(3,3) Computer Control Systems: PR: EEL 3657. Discrete-time systems, the z-transform, and single loop computer control systems. Digital simulation in the analysis and design of processes with embedded computers. No graduate credit for both EEL 5630 and this course.
EE, CpE	EEL 4650 Introduction to Sensors PR: EEL 3123C with a "C" (2.0) or better grade. Basics of measurements, physics of energy transduction, sensor specifications (range, sensitivity, accuracy, repeatability, noise), applications, basics of signal conditioning.

Program	Course
EE, CpE	EEL 4660 ECS-EECS 3(3,0) Robotic Systems: PR: EGN 3420 or EGN4060C or EML 3034C or MAS 3105. Development of a robotic system incorporating concepts such as forward/inverse kinematics, Jacobian, manipulability, probability-based path planning, position control, computer vision based control, and force/impedance control.
CpE EE3	EEL 4750 ECS-EECS 3(3,0) Digital Signal Processing Fundamentals: PR: EEL 3123C with a grade of "C" (2.0) or better. Study of discrete-time signals and systems, Z-transform, DFT introduction to digital filter design.
EE	EEL 4768 ECS-EECS 3(3,0) Computer Architecture: PR: EEL 3801C or CDA 3103C with a grade of "C" (2.0) or better. Computer systems performance and evaluation, processor datapath and control, microprogrammed architectures, instruction and arithmetic pipelines, cache and virtual memory, and RISC vs. CISC.
EE CpE1	EEL 4781 ECS-EECS 3(3,0) Computer Communication Networks: PR: EEL 3801C with a grade of "C" (2.0) or better and STA 3032. Network models. Media access protocols. Data link control. Routing and flow control. Internetworking. Current architectures and protocols: OSI, ethernet, token, ring, FDDI, HSLC, X.25, etc. CpE1 – Starting with catalog year 2025-2026; not previous catalog years.
EE, CpE	EEL 4783 ECS-EECS 3(3,0) Hardware Description Languages in Digital Systems Design: PR: EEE 3342C with a grade of "C" (2.0) or better. Hardware description languages, simulation and synthesis of RTL circuits and systems, design examples and projects.
EE, CpE	EEL 4798 ECE-EECS 3(3,0) Massive Storage and Big Data: PR: EEL 3801C or CDA 3103C . Fundamentals in big data architecture and its enabling file storage systems Infrastructure such as MapReduce and storage, with a focus on system architecture, file storage, programming models, application development and performance evaluation.
EE, CpE	EEL 4810 - Fundamentals of Neural Networks and Deep Learning: PR: EGN3211 or COP3223C with a grade of "C" (2.0) or better and MAC2313 or MAS3105. This course gives a basic understanding of deep neural networks and their applications to autonomous cyber-physical systems, intelligent edge computing, and biomedical devices.
EE, CpE	EEL 4817H ECS-EECS 3(3,0) Honors Current Topics in Machine Learning II: PR: Consent of Honors and EEL 4818H. Research topics in Machine Learning. Students will be assigned a research project and a faculty mentor who will supervise this project.
EE, CpE	EEL 4832 ECS-EECS 3(3,0) Engineering Applications of Computer Methods: PR: EEL 3123C and EGN 3211 both with a grade of "C" (2.0) or better. Engineering applications of numerical methods, including solution of differential equations, simulation, optimization, and multidimensional root-finding, integration and series approximations.
EE, CpE	EEL 4851C ECS-EECS 4(3,3) Engineering Data Structures: PR: EEL 3801C with a grade of "C" (2.0) or better. Design of data structures and algorithms, with emphasis on performance analysis, memory organization, stacks, queues, linked lists, trees, graphs, searches, and sorts. Introduction to object-oriented structures.
CpE	EEL 4872 ECS-EECS 3(3,0) Engineering Applications of Intelligent Systems: PR: EEL 4851C or COP 3503C or equivalent or C.I. Knowledge and intelligence, predicate logic and automated reasoning, heuristic search, knowledge representation, automated planning, introduction to machine learning, knowledge-based systems and philosophy of AI.
EE, CpE	EEL 4879 IoT Systems Design; PR: ECE Majors EEL 4742C with a grade of "C" (2.0) or better; Non-ECE Majors COP 3503C with a grade of "C" (2.0) or better. Internet-of-Things (IoT) systems design; RTOS-based microcontroller firmware; Bluetooth Low Energy (BLE); BLE mesh network; Wi-Fi connectivity; mobile app development.
EE, CpE	EEL 4882 ECS-EECS 3(3,0) Engineering Systems Software: PR: EEL 3801C. Introduction to operating systems concepts and facilities for engineering applications, including multiprogramming, resource allocation and management, systems utilities, and operating system implementation.
EE, CpE	EEL 4884C ECS-EECS 4(3,3) Engineering Software Design: PR: EEL 4851C. Software systems development life cycle, function and object-oriented methodologies, CASE; Analysis, design, and development of a large software project.
EE, CpE	EEL 4890 ECS-EECS 3(3,0) Continuous System Simulation I: PR: MAP 2302. Numerical integration techniques and discrete time system models for approximating the dynamics of continuous systems.

Program	Course
EE, CpE	EEL 5173 ECS-EECS 3(3,0) Linear Systems Theory: PR: EEL 3657. Models and properties of linear systems, transformation, controllability and observability, control and observer designs, MFD, and realization theory.
EE, CpE	EEL 5185 ECS-EECS 3(3,0) System Identification: PR: EEL 3657 or C.I. Dynamic systems, models of time-invariant linear, time-varying and nonlinear systems, nonparametric frequency and time domain identification methods, kernel expansion techniques, parameter estimation methods, experiment design, and applications.
EE, CpE	EEL 5245C ECS-EECS 3(2,1) Power Electronics: PR: EEE 4309C. Principles of power electronics, power semiconductor devices, inverter topologies, switch-mode and resonant dc-to-dc converters, cyclo-converters, applications.
EE	EEL 5250 ECS-EECS 3(3,0) Power System Detection and Estimation: PR: EEL 4216 or C.I. This is an advanced course to power engineering, designed to provide students with the knowledge of stability and outage detection and state estimation methods.
EE	EEL 5255 Advanced Power Systems Analysis: PR: EEL 4216 or C.I. This is an advanced course in power systems engineering, designed to provide a student with the knowledge of steady-state analysis in power system operation.
EE	EEL 5268 - Communications and Networking for Smart Grid: PR: EEL 4515C. Introduction to smart grid communication infrastructure, communication technologies in smart grid, communication networking in smart grid, communication for vehicle-to-grid systems, secure communication, and networking.
EE	EEL 5691 Biomedical Sensors: Prerequisite(s): EEL 4750 or EEL 4832 or C.I. Study of engineering concepts behind the various biomedical sensors used to monitor a patient undergoing clinical therapy.
EE	EEL 5291 ECS-EECS 3(3,0) Distributed Control and Optimization for Smart Grid: PR: EEL 3657 and EEL 4216 or C.I. Electric power systems, transmission and distribution networks, voltage stability and VAR control, dispatch of distributed generation, optimization, frequency control, electricity markets and incentive controls.
EE	EEL 5296 ECS-EECS 3(3,0) Advanced Microgrid Design and Operation PR: EEL 4216. Advanced course to power systems engineering, designed to provide students with the knowledge of microgrid system fundamentals, design, and operation.
EE	EEL 5297 - Introduction to Smart Grid: **PR**: (EEE 3307C and EEL 3657) or EEL 4216 or C.I. Fundamentals of electric power systems, distributed generation and smart grid components, voltage control and VAR compensation, demand response, leader-follower optimization, resiliency.
EE	EEL 5385 Introduction to Space Electronics PR: Completed or concurrently, EEE 3350 Key concepts and an in-depth overview of electrical, mechanical, optical and photonic devices that operate in space.
EE	EEL 5432 ECS-EECS 3(3,0) Satellite Remote Sensing: PR: EEL 3470 or PHY 4324. Fundamentals of satellite remote sensing, orbits and geometry, radiative transfer theory, microwave and infrared sensing techniques, ocean,ice and atmosphere geophysical measurements.
EE	EEL 5437C ECS-EECS 4(3,3) Microwave Engineering: PR: EEL 3470 or C.I. Transmission line theory, Smith charts, S-parameters, simple impedance matching circuits, wave guides, resonators, basic microwave measurements. M&S fee: $40 EEL4436C or EEL5437C not both
EE	EEL 5439C ECS-EECS 4(3,3) RF and Microwave Active Circuits: PR: EEL 4436C or EEL 5437C or equivalent. Transmission line, microwave network theory, impedance matching, noise, power gain amplifier, low noise amplifier, power amplifier, oscillator, mixer and microwave communication system. M&S fee: $40.00
EE	EEL 5462 ECS-EECS 3(3,0) Antenna Analysis and Design: PR: EEL 3470 or equivalent. Fundamentals of antennas; dipoles, loops, arrays, apertures, and horns. Analysis and design of various antennas.

Program	Course
EE2	EEL 5582 - Fundamentals of Wireless Communications: PR: EEL 4515C and EEL 3021. Large and small scale radio propagation effects, performance of digital modulation over wireless channels, capacity analysis of wireless channels, signal processing techniques to mitigate fading effects and improve performance of wireless systems (diversity techniques, adaptive modulation, multiple antenna and MIMO systems).
EE	EEL 5625 ECS-EECS 3(3,0) Applied Control Systems: PR: C.I. Designed to develop basic understanding of advanced control methods for nonlinear systems described by ordinary and partial differential equations and to expose recent results and ongoing research issues in the area of MEMS.
EE, CpE	EEL 5630 ECS-EECS 3(3,0) Digital Control Systems: PR: EEL 3657. Real-time digital control system analysis and design, Z-transforms, sampling and reconstruction, time and frequency response, stability analysis, digital controller design. No graduate credit for both EEL 5630 and EEL4635C.
EE, CpE	EEL 5659 - Introduction to Sensors: PR: EEL 3123C. Basics of measurements, physics of energy transduction, sensor specifications (range, sensitivity, accuracy, repeatability, noise), applications, basics of signal conditioning.
EE, CpE	EEL 5669 ECS-EECS 3(3,0) Introduction to Robotics and Autonomous Vehicles PR: EEL 5173 or C.I. Forward and inverse kinematics, velocity kinematics, dynamics, constrained motions, path and trajectory planning, position and trajectory control, single and multivariable control, introduction to force/impedance control, introduction to consensus-based control.
EE	EEL 5690 ECS-EECS 3(3,0) Medical Robotics: PR: EEL 3657 or Medical students in their second year or later. Medical robots for minimally invasive surgery, kinematics, constrained workspace and dexterity, haptics, tele-operation and network based control, basics of laparoscopic surgery.
CpE	EEL 5706 Resilient Computer System Design: EEL 4768 or CDA 5106 or EEL 5708, or C.I. Advanced concepts in hardware/software fault tolerance: fault models, coding in computer systems, module and system level fault detection mechanisms, such as TMR, rollback, and recovery.
EE, CpE	EEL 5722C ECS-EECS 3(2,3) Field-Programmable Gate Array (FPGA) Design: PR: EEE 3342C with a "C" (2.0) or better grade. FPGA architectures, design flow, technology mapping, placement, routing, reconfigurable computing applications, and evolvable hardware.
EE, CpE	EEL 5780 ECS-EECS 3(3,0) Wireless Networks: PR: EEL 4781 or C.I. The wireless networking topics include: cellular networks, multiple access protocols, channel assignment and resource allocation, mobility and location management, handoffs, routing, authentication, call admission control and QoS provisioning, network layer issues, wireless data networking (WAP, GSM, GPRS, CDMA, WCDMA.).
CpE	EEL 5789 Software-Defined Networking: PR: EEL 4781. Fundamentals of software-defined networking (SDN). Control, data, and management plane separation. Northbound and southbound APIs. Network function virtualization (NFV), network orchestration, service chaining. SDN and NFV protocols and controllers such as OpenFlow, OpenDaylight, Floodlight, and Open Network Operating System (ONOS).
CpE	EEL 5796 Big Data Computer Architecture and Systems: PR: EEL 4768 or CGS 3763 or C.I. Computer hardware architecture and operating systems design, implementation and administrative techniques for big data computing platforms which run applications to analyze datasets of massive size and dimensionality.
EE, CpE	EEL 5820 ECS-EECS 3(3,0) Image Processing: PR: MAP 2302, EEL 4750 or C.I. Two-dimensional signal processing techniques; pictorial image representation; spatial filtering; image enhancement and encoding; segmentation and feature extraction; introduction to image understanding techniques.
EE, CpE	EEL 5825 ECS-EECS 3(3,0) Machine Learning and Pattern Recognition: PR: EEL 3021 or STA 3032. Preliminaries of pattern recognition, Bayesian Decision Theory, linear discriminant functions, Neural Network approaches, decision tree classifiers, unsupervised learning and clustering, non-parametric techniques, and other topics reflecting the state-of-the art.
CpE	EEL 5860 Software Requirements Engineering: PR: Graduate standing or C.I. Excellent oral and written communication skills. Excellent problem solving skills. In-depth study of software requirements engineering within a process centered framework. Methods for requirements elicitation, analysis, description, and validation. Formal and informal specification.
EE, CpE	EEL5862 Real-Time Systems: Prerequisites: COP4600 or EEL4768 or EEL4742C. Introduction to specification, analysis, design, and validation techniques for real-time (operating) systems with an emphasis on real-time scheduling theory. EEE4775 or EEL5862 not both

Program	Course
CpE	EEL 5874 ECS-EECS 3(3,0) Expert Systems and Knowledge Engineering: PR: EEL 4872 or CAP 4630 C.I. Introduction to expert systems in engineering. Expert systems tools and interviewing techniques. This course is hands-on and project oriented.
CpE	EEL 5881 ECS-EECS 3(3,0) Software Engineering I: PR: Graduate standing with Computer Engineering Covers fundamentals of software engineering and software design patterns
EE, CpE	EGN 4060C ECS-ECS 3(2,3) Introduction to Robotics: PR: COP 3223C or EGN 3211 with a "C" (2.0) or better; and EEL 3657or EEL 4742C or COP 3503C or EGN 3321 with a "C" (2.0) or better. Theory and application of robotics topics including; architecture, path planning, sensing and manipulation.
CpE	CAP 4053 ECS-EECS 3(3,0) AI for Game Programming: PR: CS Foundation Exam or COP 3502C with a grade of C or better or C.I. Surveys cutting-edge AI techniques for video games and board games and contrasts them with more traditional approaches.
CpE	CAP 4453 ECS-EECS 3(3,0) Robot Vision: PR: COP 3503C and MAC 2312 with a grade of C or better, or C.I. Perspective and orthographic projections; the processing of edges, regions, motion, shading, texture, object detection, recognition, and machine learning.
CpE	CAP 4611 - Algorithms for Machine Learning. Prerequisite(s): COP 3502C and STA 2023 each with a grade of "C" (2.0) or better. An overview of the most commonly used algorithms for supervised, unsupervised, and reinforcement learning. Introduction to experimental design, evaluation metrics, and applications of machine learning.
CpE	CAP 4720 ECS-EECS 3(3,0) Computer Graphics: PR: COP 3503C and MAC 1114C each with a grade of C or better and COT 3960. Math for computer graphics, visibility and shading, graphics and data structure, curves and surfaces, commodity graphics hardware, and graphics API.
CpE	CAP 5055 ECS-EECS 3(3,0) AI for Game Programming: PR: CS Foundation Exam or EEL 4851C or C.I. Surveys cutting-edge AI techniques for video games and board games and contrasts them with more traditional approaches.
CpE	CAP 5100 ECS-EECS 3(3,0) Human-Computer Interface Design: PR: COP 4331C, graduate standing and/or approval of the Director of the Software Engineering Certificate Program. Focuses on dynamics of human-computer interaction. Provides a comprehensive overview of HCI design as a software discipline. Features a user-centered approach to Web-based application design.
CpE	CAP 5415 ECS-EECS 3(3,0) Computer Vision: PR: COP 3503C, MAC 2312 and COT 3960. Image formation, binary vision, region growing and edge detection, shape representation, dynamic scene analysis, texture, stereo and range images, and knowledge representation.
CpE	CAP 5510 ECS-EECS 3(3,0) Bioinformatics: PR: Background in programming language or molecular biology. This course introduces problems, concepts, algorithms, and applications in Bioinformatics. It covers essential topics such as sequence alignment and prediction of gene and protein structure.
CpE	CAP 5512 ECS-EECS 3(3,0) Evolutionary Computation: PR: CAP 4630 or COP 3503C or C.I. This course covers the field of evolutionary computation, focusing on the theory and application of genetic algorithms. CAP4611 is a PR substitute
CpE	CAP 5610 ECS-EECS 3(3,0) Machine Learning: PR: CAP 4630 or C.I. Origin/evaluation of machine intelligence; machine learning concepts and their applications in problem solving, planning and "expert systems" symbolic role of human and computers. CAP4611 is a PR substitute
CpE	CAP 5636 ECS-EECS 3(3,0) Advanced Artificial Intelligence: PR: CAP 4630. AI theory of knowledge representation, "expert systems", memory organization, problem solving, learning, planning, vision, and natural language. CAP4611 is a PR substitute
CpE	CAP 5725 ECS-EECS 3(3,0) Computer Graphics I: Architecture of graphics processors; display hardware; principles of programming and display software; problems and applications of graphic systems.
CpE	CDA 5106 ECS-EECS 3(3,0) Advanced Computer Architecture: PR: EEL 4768C. Modern processor design, instruction-level parallelism, thread-level parallelism, data-level parallelism, memory hierarchy, and I/O.

Program	Course
CpE	CDA 5110 ECS-EECS 3(3,0) Parallel Architecture and Algorithms: PR: COT 4210, CDA 5106. General-purpose vs. special-purpose parallel computers; arrays, message-passing; shared-memory; taxonomy; parallization techniques; communication synchronization and granularity; parallel data structures; automatic program restructuring.
CpE	CEN 5016 ECS-EECS 3(3,0) Software Engineering: PR: COP 4331C. Application of formal software processes, engineering methods, and documentation standards to the development of large scale software systems. A team project is required.
CpE	CNT 4403 ECS-EECS 3(3,0) Network Security and Privacy: PR: (CNT 3004 or EEL 4781 or CNT 4704) and (CIS 3360 or CIS 3362) all with a grade of "C" (2.0) or better or C.I. Fundamentals of network security, protocols, secure applications, network intrusion detection, security policy, firewalls, and privacy issues.
CpE	CNT 4714 ECS-EECS 3(3,0) Enterprise Computing: PR: (CGS 3269, MAD 2104, COP 3330 and COP 3502C) or (COP 3503C and Computer Science or Computer Engineering major) all with a grade of "C" (2.0) or better. Client-server architecture. Server- side scripting: Servlets, JSP, PHP. JDBC and MySQL database; connectivity. Multi-threaded Java applications. J2EE development. SSL., Event-driven programming.
CpE	CNT 5008 ECS-EECS 3(3,0) Computer Communication Networks Architecture: PR: EEL 4768C. Computer networks, layers, protocols and interfaces, local area networks networking.
CpE	COP 4020 ECS-EECS 3(3,0) Programming Languages I: PR: COP 3503C with a grade of "C" (2.0) or better and COT 3960. Paradigms and fundamental concepts of programming languages are presented, including: scope, binding, abstraction, encapsulation, typing etc. Design paradigms object-oriented, functional and logic programming are presented.
CpE1	COP 4331C ECS-EECS 3(3,1) Processes for Object-Oriented Software Development: PR: COP 3503C with a grade of "C" (2.0) or better and COT 3960 (CS majors). Concepts, principles, processes and methods for developing large software systems featuring a team project using object-oriented design in UML and implementation in C++.
CpE	COP 4516C ECS-EECS 3(1,3) Problem Solving Techniques and Team Dynamics: PR: COP 3503C with a grade of "C" (2.0) or better. Design and implement solutions to problems requiring the applications of the different algorithms. Team project format.
CpE	COP 4520 ECS-EECS 3(3,0) Concepts of Parallel and Distributed Processing: PR: COP 3402 and COP 3503C each with a grade of "C" (2.0) or better and COT 3960. Parallel and distributed paradigms, architectures and algorithms, and the analytical tools, environments and languages needed to support these paradigms.
CpE1	COP 4600 ECS-EECS 3(3,0) Operating Systems: PR: COP 3503C and COP 3402 (CS majors) each with a grade of "C" (2.0) or better and COT 3960 (CS majors). Function and organization of operating systems, process management, virtual memory, I/O management, and file management.
CpE	COP 4710 ECS-EECS 3(3,0) Database Systems: PR: COP 3503C with a grade of "C" (2.0) or better. Storage and access Structures, database models and languages, related database design, and implementation techniques for database management systems.
CpE	COP 5021 ECS-EECS 3(3,0) Program Analysis: PR: COP 4020 and COT 4210 or C.I. Static analysis of programs including theoretical and practical limitations, data flow analysis, abstract interpretation, and type and effect systems. Tools to automate program analysis.
CpE	COP 5537 ECS-EECS 3(3,0) Network Optimization: PR: Graduate standing or C.I. Techniques for modeling complex, interconnected systems as networks; optimization with graph theory; algorithms, data structures, and computational complexity; statistical methods for studying large, evolving networks.
CpE	COP 5611 ECS-EECS 3(3,0) Operating Systems Design Principles: PR: COP 4600. Structure and functions of operating systems, process communication techniques, high-level concurrent programming, virtual memory systems, elementary queuing theory, security, distributed systems, case studies.
CpE	COP 5621 ECS-EECS 3(3,0) Compiler Construction: PR: COP4020 and COT 4210. Techniques in the design and implementation of compilers. Optimization, code generation, error recovery, attributed grammars. A project is required.

Program	Course
CpE	COP 5711 ECS-EECS 3(3,0) Parallel and Distributed Database Systems: PR: COP 4710. Storage manager, implementation techniques for parallel DBMSs, distributed DBMS architectures, distributed database design, query processing, multi-database systems.
CpE	COT 4210 ECS-EECS 3(3,0) Discrete Structures II: PR: COP 3503C and MAC 2312 each with a grade of "C" (2.0) or better and COT 3960. Computation Theory. A study of the properties of grammars and automata as formal specifications for algorithms and families of languages.
CpE	COT 5405 ECS-EECS 3(3,0) Design and Analysis of Algorithms: PR: COT 4210. Classification of algorithms, e.g., recursive, divide- and-conquer, greedy, etc. Data Structures and algorithm design and performance. Time and space complexity analysis.