# ELECTRICL + COMPUTER ENGRG-ECE (ECE)

## Courses

**ECE 101 Foundations in ECE Credit: 1 (1-0-0)**
**Course Description:** Introduction to the field of Electrical and Computer Engineering, including exploration of the diversity of technical areas, application of the engineering method, and investigation of a range of potential careers. Hands-on application of technical concepts through completion of an Arduino-based project.
**Prerequisite:** None.
**Restrictions:** Must not be a: Junior, Senior. Must be a: Undergraduate.
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 102 Digital Circuit Logic Credits: 4 (3-2-0)**
**Course Description:** Fundamentals of digital circuit logic, including Boolean algebra; Karnaugh maps; multiplexers, decoders, ROMS, PLAS, flip-flops, counters; sequential networks; and state tables.
**Prerequisite:** None.
**Registration Information:** Must register for lecture and laboratory. Sections may be offered: Online.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 103 DC Circuit Analysis Credits: 3 (2-2-0)**
**Course Description:** Basic DC circuit analysis, including the use of relevant software to solve problems and analyze results from projects.
**Prerequisite:** MATH 159 with a minimum grade of C or MATH 160 with a minimum grade of C.
**Registration Information:** Must register for lecture and laboratory. Sections may be offered: Online.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 202 Circuit Theory Applications Credits: 4 (3-3-0)**
**Course Description:** Basic circuit analysis techniques and applications to engineering design problems.
**Prerequisite:** ECE 103 with a minimum grade of C and MATH 161 with a minimum grade of C.
**Registration Information:** Must register for lecture and laboratory.
**Terms Offered:** Spring, Summer.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 204 Introduction to Electrical Engineering Credits: 3 (3-0-0)**
**Course Description:** Basic analog and digital circuits and systems; introduction to electromechanical devices.
**Prerequisite:** MATH 161 and PH 142.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 205 Analog Circuits I Credits: 3 (2-2-0)**
**Course Description:** Basic DC circuit analysis, including the use of relevant software to solve problems and analyze results from projects.
**Prerequisite:** MATH 159 with a minimum grade of C, may be taken concurrently or MATH 160 with a minimum grade of C, may be taken concurrently.
**Restriction:** Must be a: Undergraduate.
**Registration Information:** Must register for lecture and laboratory. Sections may be offered: Online. Credit not allowed for both ECE 103 and ECE 205.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** Yes.

**ECE 206 Analog Circuits II Credits: 3 (3-3-0)**
**Course Description:** Parasitic effects in the circuits through studies of 1st and 2nd order circuits. Introduction of AC sources, ideal operational amplifiers, and transformers. Transfer function and analysis of circuits in frequency domain. Implementation of gained knowledge to solve engineering design problems.
**Prerequisite:** (ECE 103 with a minimum grade of C or ECE 205 with a minimum grade of C) and (MATH 161 with a minimum grade of C).
**Restriction:** Must be a: Undergraduate.
**Registration Information:** Must register for lecture and laboratory. Credit not allowed for both ECE 202 and ECE 206.
**Terms Offered:** Spring, Summer.
**Grade Mode:** Traditional.
**Special Course Fee:** Yes.

**ECE 232 Introduction to Project Practices Credit: 1 (1-0-0)**
**Course Description:** Development of project skills and professionalism within the electrical and computer engineering (ECE) discipline through individual and group project work guided by ECE industry leaders.
**Prerequisite:** ECE 202, may be taken concurrently or ECE 206, may be taken concurrently or ECE 395B, may be taken concurrently.
**Registration Information:** Credit not allowed for both ECE 232 and ECE 280A1.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 251 Introduction to Microcontrollers and IoT Credits: 4 (3-3-0)**
**Course Description:** Microprocessor organization, Internet of Things (IoT) platforms, microprocessor coding using C and assembly language, I/O techniques, real-time interfaces, and applications.
**Prerequisite:** ECE 102 with a minimum grade of C.
**Registration Information:** Must register for lecture and laboratory. Sections may be offered: Online.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 252 Introduction to Digital Circuits Credits: 3 (3-2-0)**
**Course Description:** Fundamentals of digital circuit logic including Boolean algebra; Karnaugh maps; multiplexers, decoders, Read Only Memories (ROMS), Programmable Logic Devices (PLAs), flip-flops; sequential networks; and state tables.
**Prerequisite:** None.
**Restriction:** Must be a: Undergraduate.
**Registration Information:** Must register for lecture and laboratory. Sections may be offered: Online. Credit not allowed for both ECE 102 and ECE 252.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** Yes.

**ECE 253 Microcontrollers and C for Internet-of-Things Credits: 3 (3-3-0)**
**Course Description:** Microprocessor and microcontroller organization; microprocessor coding using the C language; Internet-of-Things (I/O) devices, protocols, and applications.
**Prerequisite:** ECE 102 with a minimum grade of C or ECE 252 with a minimum grade of C or MECH 207 with a minimum grade of C.
**Restriction:** Must be a: Undergraduate.
**Registration Information:** Must register for lecture and laboratory. Sections may be offered: Online. Credit not allowed for both ECE 251 and ECE 253.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** Yes.

**ECE 303 Introduction to Communications Principles Credits: 3 (3-0-0)**
**Also Offered As:** STAT 303.
**Course Description:** Probability and random variables with applications in the design and analysis of communication and electronic systems.
**Prerequisite:** MATH 261 with a minimum grade of C.
**Registration Information:** Sections may be offered: Online. Credit not allowed for both ECE 303 and STAT 303.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 311 Linear System Analysis I Credits: 3 (3-0-0)**
**Course Description:** Continuous and discrete time signals and systems representations in time and frequency domain; time convolution.
**Prerequisite:** None.
**Registration Information:** [(ECE 202 with a minimum grade of C or ECE 206 with a minimum grade of C) and ECE 331, may be taken concurrently and ECE 341, may be taken concurrently and MATH 340 with a minimum grade of C] or [(CS 356, may be taken concurrently or ECE 451, may be taken concurrently or ECE 528, may be taken concurrently) and (ECE 202 with a minimum grade of C or ECE 206 with a minimum grade of C) and MATH 340 with a minimum grade of C].
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 312 Linear System Analysis II Credits: 3 (3-0-0)**
**Course Description:** Laplace and Z transforms, applications to modulation, filtering and sampling, state space representation.
**Prerequisite:** ECE 311 with a minimum grade of C.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 331 Electronics Principles I Credits: 4 (3-3-0)**
**Course Description:** Discrete component semiconductor devices, characteristics and applications. Rectifier circuits, single-stage and multi-stage amplifiers.
**Prerequisite:** None.
**Registration Information:** Must register for lecture and laboratory. [(ECE 202 with a minimum grade of C or ECE 206 with a minimum grade of C) and ECE 311, may be taken concurrently and ECE 341, may be taken concurrently and MATH 340 with a minimum grade of C and PH 142 with a minimum grade of C] or [(CS 356, may be taken concurrently or ECE 451, may be taken concurrently or ECE 528, may be taken concurrently) and (ECE 202 with a minimum grade of C or ECE 206 with a minimum grade of C) and ECE 311, may be taken concurrently and MATH 340 with a minimum grade of C and PH 142 with a minimum grade of C].
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** Yes.

**ECE 332 Electronics Principles II Credits: 4 (3-3-0)**
**Course Description:** Discrete and integrated-circuit amplifiers-frequency response, negative feedback.
**Prerequisite:** ECE 331 with a minimum grade of C.
**Registration Information:** Must register for lecture and laboratory.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** Yes.

**ECE 340 Electromagnetics for Computer Engineering Credits: 3 (3-0-0)**
**Course Description:** Fundamentals of electromagnetic theory for computer engineering; applications of electromagnetics in VLSI design, silicon photonics, radar, antenna, and communication; vector analysis; static electromagnetic fields; boundary conditions; time-varying electromagnetic field; Maxwell's equations; connection between circuit theory and electromagnetics; waveguides, and fiber optics.
**Prerequisite:** (ECE 202 with a minimum grade of C or ECE 206 with a minimum grade of C) and (MATH 161 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online.
**Term Offered:** Fall (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 341 Electromagnetic Fields and Devices I Credits: 3 (3-0-0)**
**Course Description:** Basic concepts of electrostatic and magnetostatic fields.
**Prerequisite:** (ECE 202 with a minimum grade of C or ECE 206 with a minimum grade of C) and (PH 142 with a minimum grade of C and ECE 311, may be taken concurrently and ECE 331, may be taken concurrently and MATH 340 with a minimum grade of C).
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 342 Electromagnetic Fields and Devices II Credits: 3 (3-0-0)**
**Course Description:** Basic concepts of time varying electromagnetic fields and transmission lines.
**Prerequisite:** ECE 341 with a minimum grade of C.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 395A Independent Study Credits: Var[1-6] (0-0-0)**
**Course Description:** Development and implementation of a project in an Electrical and Computer Engineering field of special interest under the supervision of a faculty member.
**Prerequisite:** None.
**Registration Information:** Contact department for registration. May be taken up to 6 times for credit.
**Terms Offered:** Fall, Spring, Summer.
**Grade Mode:** Instructor Option.
**Special Course Fee:** No.

**ECE 395B Independent Study: Open Option Project Credits: Var[1-6] (0-0-0)**
**Course Description:** Students will work on an array of different electrical and computer engineering projects independently or under the guidance of industry mentors. Projects will be initiated by students or outside sources and will consist of small-scale service/outreach projects or market-driven projects that simulate a business environment.
**Prerequisite:** None.
**Registration Information:** Contact department for registration. May be taken up to 6 times for credit.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Instructor Option.
**Special Course Fee:** No.

**ECE 395C Independent Study : Vertically Integrated Project Credits: Var[1-6] (0-0-0)**
**Course Description:** Explore and develop comprehensive applications of electrical and computer engineering technologies as a member of a team, especially as they relate to active research areas of CSU faculty members.
**Prerequisite:** None.
**Registration Information:** Contact department for registration. May be taken up to 6 times for credit.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Instructor Option.
**Special Course Fee:** No.

**ECE 401 Senior Design Project I Credits: 3 (1-4-0)**
**Course Description:** Advanced project, seminar series, formal written report, and oral presentation.
**Prerequisite:** None.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Must register for lecture and laboratory. (ECE 232 with a minimum grade of C; ECE 312 with a minimum grade of C or (PH 314 with a minimum grade of C and PH 353 with a minimum grade of C); ECE 332 with a minimum grade of C; ECE 342 with a minimum grade of C) or (ECE 232 with a minimum grade of C; ECE 311 with a minimum grade of C; 4 courses from the following: CS 356, ECE 312 with a minimum grade of C, ECE 331 with a minimum grade of C, ECE 332 with a minimum grade of C, ECE 450 and ECE 451, ECE 452, ECE 456, ECE 528). Sections may be offered: Online.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** Yes.

**ECE 402 Senior Design Project II Credits: 3 (1-4-0)**
**Course Description:** Advanced project, formal report, and oral presentation.
**Prerequisite:** ECE 401.
**Registration Information:** Must register for lecture and laboratory. Sections may be offered: Online.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** Yes.

**ECE 403 Intro to Optical Techniques in Biomedical Eng Credits: 3 (3-0-0)**
**Also Offered As:** BIOM 403.
**Course Description:** Engineering design principles of optical characterization techniques for biomedical systems, including optical spectroscopy and microscopy of biomolecules and tissues.
**Prerequisite:** CHEM 111 and PH 142 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit allowed for only one of the following: BIOM 403, BIOM 481A3, ECE 403, or ECE 481A3.
**Term Offered:** Fall (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 404 Experiments in Optical Electronics Credits: 2 (1-3-0)**
**Course Description:** Experiments in optical electronics and lasers.
**Prerequisite:** None.
**Registration Information:** Must have concurrent registration in ECE 441. Must register for lecture and laboratory.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 411 Control Systems Credits: 3 (3-0-0)**
**Course Description:** Control system analysis and design for linear systems: stability and performance; time and frequency domain techniques.
**Prerequisite:** ECE 312 with a minimum grade of C.
**Registration Information:** Sections may be offered: Online. Credit not allowed for both ECE 411 and MECH 417.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 412 Digital Control and Digital Filters Credits: 3 (3-0-0)**
**Course Description:** FIR and IIR digital filter design, analog and digital invariance and direct digital control algorithms, hybrid systems analysis.
**Prerequisite:** ECE 411 or MECH 417.
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 415 Semiconductor Physics and Junctions Credits: 2 (2-0-0)**
**Course Description:** The fundamental physics of semiconductor band structure and of the modifications that occur by doping. These fundamental concepts allow for developing the model of a pn junction diode, which is the basic unit of electronic devices.
**Prerequisite:** (MATH 340 with a minimum grade of C or MATH 345 with a minimum grade of C) and (PH 142 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Credit allowed for only one of the following: ECE 415, ECE 471A, or ECE 471B.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 421 Telecommunication Credits: 3 (3-0-0)**
**Course Description:** Analog communication (modulation), digital communication (sampling, quantization, equalization, detection and error probability analysis).
**Prerequisite:** (ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C or STAT 315 with a minimum grade of C) and (ECE 312 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing. Sections may be offered: Online.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 430 Fourier and Wavelet Analysis with Apps Credits: 3 (3-0-0)**
**Also Offered As:** MATH 430.
**Course Description:** Fourier analysis and transforms, FFTs; sampling theorems, computational algorithms; wavelets; applications to communication, imaging, and compression.
**Prerequisite:** MATH 340 or MATH 345.
**Registration Information:** Credit not allowed for both ECE 430 and MATH 430.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 431 Biomedical Signal and Image Processing Credits: 3 (3-0-0)**
**Also Offered As:** BIOM 431.
**Course Description:** Principles, features and mathematical processing of biomedical signals and images including interference and noise filtering and feature enhancement.
**Prerequisite:** (ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C) and (ECE 311 with a minimum grade of C and PH 142 with a minimum grade of C).
**Registration Information:** Sections may be offered: Online. Credit not allowed for both BIOM 431 and ECE 431.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 441 Optical Electronics Credits: 3 (3-0-0)**
**Course Description:** Concepts of modern physics, optical properties of atoms, light sources, lasers, optical detectors, optical cavities, and optical fiber transmission.
**Prerequisite:** ECE 340 with a minimum grade of C or ECE 342 with a minimum grade of C.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 444 Antennas and Radiation Credits: 3 (3-0-0)**
**Course Description:** Retarded potential theory, antenna arrays, long wire antennas, dipoles, aperture antennas, receiving antennas.
**Prerequisite:** ECE 340 with a minimum grade of C or ECE 342 with a minimum grade of C.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 445 Digital Logic Synthesis Credits: 3 (3-0-0)**
**Course Description:** Application of a top-down design methodology to optimize circuits to achieve better power, performance, timing, and area. Advanced concepts in logic optimization, simulation and testing, and synchronous and asynchronous circuits, as well as a comprehensive review of high-level hardware description languages and the extraction of gate-level circuits from these representations.
**Prerequisite:** ECE 102 with a minimum grade of C or ECE 252 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit not allowed for both ECE 445 and ECE 480A4.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 450 Digital System Design Laboratory Credit: 1 (0-3-0)**
**Course Description:** Small digital circuits are designed and simulated using very high speed hardware description language and synthesis tools.
**Prerequisite:** None.
**Registration Information:** Must have concurrent registration in ECE 451.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 451 Digital System Design Credits: 3 (3-0-0)**
**Course Description:** State machines with PLAs as controllers and small computers; timing and race elimination considerations; state and microprogramming implementation.
**Prerequisite:** None.
**Registration Information:** Concurrent registration in ECE 450. [(ECE 102 with a minimum grade of C or ECE 252 with a minimum grade of C) and (ECE 202 with a minimum grade of C or ECE 206 with a minimum grade of C)] or MECH 307 with a minimum grade of C.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 452 Computer Organization and Architecture Credits: 3 (3-0-0)**
**Course Description:** CPU design; microarchitecture; data path and control path; pipelining; memory system; I/O system; program optimization by system software/hardware.
**Prerequisite:** CS 250 with a minimum grade of C or CS 270 with a minimum grade of C or ECE 251 with a minimum grade of C or ECE 253 with a minimum grade of C.
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 455 Introduction to Robot Programming/Simulation Credits: 3 (3-0-0)**
**Course Description:** Fundamentals of simulating and programming of workcells that include robots and other articulated objects.
**Prerequisite:** CS 150B with a minimum grade of C or CS 152 with a minimum grade of C or CS 162 with a minimum grade of C or CS 163 with a minimum grade of C or CS 164 with a minimum grade of C.
**Registration Information:** Sections may be offered: Online. Credit not allowed for both MECH 416 and ECE 455.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 456 Computer Networks Credits: 4 (3-3-0)**
**Course Description:** Circuit/packet switching, protocols, LAN/MAN, TCP/IP, error correction, wireless LANS, mobile networks.
**Prerequisite:** (CS 150B with a minimum grade of C or CS 152 with a minimum grade of C or CS 162 with a minimum grade of C or CS 163 with a minimum grade of C or CS 164 with a minimum grade of C) and (ECE 251 with a minimum grade of C or ECE 253 with a minimum grade of C) and (ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C) and (ECE 311 with a minimum grade of C).
**Registration Information:** Must register for lecture and laboratory. Sections may be offered: Online.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 457 Fourier Optics Credits: 3 (3-0-0)**
**Course Description:** Introduction to optical systems for signal and information processing with emphasis on Fourier optics.
**Prerequisite:** ECE 311 with a minimum grade of C and ECE 342 with a minimum grade of C.
**Registration Information:** Sections may be offered: Online. Credit not allowed for both ECE 457 and ECE 502.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 461 Modern Power Systems Credits: 3 (3-0-0)**
**Course Description:** Fundamentals of power system modelling, planning, operation, and management. Power generation, transmission and distribution. Sustainable energy sources such as solar sites, wind farms, and their grid integration. Power system load flow, control, and transient stability analysis using computer tools.
**Prerequisite:** ECE 202 with a minimum grade of C or ECE 206 with a minimum grade of C or MECH 207 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 463 Electrical Motors and Generators Credits: 4 (3-2-0)**
**Course Description:** Principles of electric motors and generators: magnetic circuits, energy conversion, DC and AC machine operation, torque production, and control.
**Prerequisite:** ECE 202 with a minimum grade of C or ECE 206 with a minimum grade of C or MECH 207 with a minimum grade of C.
**Registration Information:** Must register for lecture and laboratory.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 495A Independent Study Credits: Var[1-6] (0-0-0)**
**Course Description:** Development and implementation of a project in an electrical and computer engineering field of special interest under the supervision of a faculty member.
**Prerequisite:** None.
**Registration Information:** Junior standing. Contact department for registration. May be taken up to 6 times for credit.
**Terms Offered:** Fall, Spring, Summer.
**Grade Mode:** Instructor Option.
**Special Course Fee:** No.

**ECE 495B Independent Study: Open Option Project Credits: Var[1-6] (0-0-0)**
**Course Description:** Students will work on an array of different electrical and computer engineering projects independently or under the guidance of industry mentors. Projects will be initiated by students or outside sources and will consist of small-scale service/outreach projects or market-driven projects that simulate a business environment.
**Prerequisite:** None.
**Registration Information:** Junior standing. Contact department for registration. May be taken up to 6 times for credit.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Instructor Option.
**Special Course Fee:** No.

**ECE 495C Independent Study: Vertically Integrated Projects Credits: Var[1-6] (0-0-0)**
**Course Description:** Explore and develop comprehensive applications of electrical and computer engineering technologies as a member of a team, especially as they relate to active research areas of CSU faculty members.
**Prerequisite:** None.
**Registration Information:** Junior standing. Contact department for registration. May be taken up to 6 times for credit.
**Terms Offered:** Fall, Spring.
**Grade Mode:** Instructor Option.
**Special Course Fee:** No.

**ECE 502 Advanced Fourier Optics Credits: 4 (3-0-1)**
**Course Description:** Introduction to optical systems for signal and information processing with emphasis on Fourier optics. Engineering design principles, models, and computational techniques for forward optical imaging and optical image reconstruction.
**Prerequisite:** ECE 311 with a minimum grade of C and ECE 342 with a minimum grade of C and MATH 340 with a minimum grade of C.
**Registration Information:** Junior standing. Must register for lecture and recitation. Sections may be offered: Online. Credit not allowed for both ECE 457 and ECE 502.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 503 Ultrafast Optics Credits: 3 (3-0-0)**
**Course Description:** Principles and theory behind ultrashort pulse generation, amplification, and manipulation.
**Prerequisite:** (ECE 341) and (ECE 342 or ECE 343).
**Term Offered:** Spring (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 504 Physical Optics Credits: 3 (3-0-0)**
**Course Description:** Classical optics from first principles; basic electromagnetic theory to wave and geometric guides.
**Prerequisite:** ECE 342 with a minimum grade of C.
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Fall (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 506 Optical Interferometry and Laser Metrology Credits: 3 (3-0-0)**
**Course Description:** High resolution metrology techniques and interferometric sensors using lasers and other light sources.
**Prerequisite:** ECE 342 with a minimum grade of C and ECE 441.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing. Sections may be offered: Online.
**Term Offered:** Fall (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 507 Plasma Physics and Applications Credits: 3 (3-0-0)**
**Course Description:** Fundamental principles and industrial applications of plasmas.
**Prerequisite:** ECE 342 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing. Sections may be offered: Online.
**Term Offered:** Spring (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 512 Digital Signal Processing Credits: 3 (3-0-0)**
**Course Description:** Discrete time signals and systems, digital filter design and implementation, fast algorithms, quantization effects.
**Prerequisite:** ECE 312 with a minimum grade of C.
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 513 Digital Image Processing Credits: 3 (3-0-0)**
**Course Description:** Image acquisition and display systems, image enhancement, restoration and encoding, image analysis; real-life applications.
**Prerequisite:** (ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C) and (ECE 312 with a minimum grade of C).
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 514 Applications of Random Processes Credits: 3 (3-0-0)**
**Course Description:** Bit-error rates, signal-to-noise power ratios, signal detection, signal estimation, Wiener filters, and applications of these concepts in electrical and computer engineering.
**Prerequisite:** (ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C) and (ECE 312 with a minimum grade of C).
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 516 Information Theory Credits: 3 (3-0-0)**
**Course Description:** Information measures and their properties; lossless data compression; channel capacity; channel coding theorem; rate distortion theorem.
**Prerequisite:** ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C or STAT 315 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore, Junior.
**Registration Information:** Senior Standing. Sections may be offered: Online.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 517 Advanced Optical Imaging Credits: 3 (3-0-0)**
**Also Offered As:** BIOM 517.
**Course Description:** Engineering design principles of advanced optical imaging techniques and image formation theory.
**Prerequisite:** ECE 342 with a minimum grade of C or MATH 340 with a minimum grade of C or MATH 345 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit allowed for only one of the following: BIOM 517, BIOM 581B7, ECE 517 or ECE 581B7.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 518 Biophotonics Credits: 3 (3-0-0)**
**Also Offered As:** BIOM 518.
**Course Description:** Engineering design principles of optical instrumentation for medical diagnostics. Light propagation and imaging in biological tissues.
**Prerequisite:** ECE 342 with a minimum grade of C or ECE 457 with a minimum grade of C or MATH 340 with a minimum grade of C or MATH 345 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit allowed for only one of the following: BIOM 518, BIOM 581A9, ECE 518 or ECE 581A9.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 519 Network Centric Systems Credits: 3 (2-3-0)**
**Course Description:** Network science concepts, fundamentals of network-centric systems, and case studies.
**Prerequisite:** (CS 165 with a minimum grade of C) and (DSCI 369 with a minimum grade of C or ECE 303 with a minimum grade of C or ECE 312 with a minimum grade of C or ECE 421 with a minimum grade of C or ECE 456 with a minimum grade of C or MATH 369 with a minimum grade of C or STAT 303 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore, Junior.
**Registration Information:** Senior standing. Must register for lecture and laboratory. Sections may be offered: Online. Credit not allowed for both ECE 519 and ECE 581B8.
**Term Offered:** Spring (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 520 Optimization Methods--Control and Comm. Credits: 3 (3-0-0)**
**Course Description:** Linear and nonlinear optimization theory and methods; applications in systems, control, and communication.
**Prerequisite:** (DSCI 369 or MATH 369) and (MATH 261 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 521 Satellite Communication Credits: 3 (3-0-0)**
**Course Description:** Principles of satellite communication systems engineering.
**Prerequisite:** ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C or STAT 315 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing. Sections may be offered: Online.
**Term Offered:** Spring (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 522 Random Walks Credits: 3 (3-0-0)**
**Also Offered As:** MATH 522.
**Course Description:** Mathematical aspects of random walks and diffusion processes. Stochastic modeling of complex systems.
**Prerequisite:** (ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C or STAT 315 with a minimum grade of C) and (ECE 312 with a minimum grade of C or ECE 457 with a minimum grade of C or MATH 469 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit allowed for only one of the following: ECE 522, ECE 681A2, and MATH 522.
**Term Offered:** Fall (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 526 Biological Physics Credits: 3 (3-0-0)**
**Also Offered As:** BIOM 526.
**Course Description:** Mathematical and physical modeling of biological systems. Mass transport in cellular environments. Electrical/mechanical properties of biomolecules.
**Prerequisite:** (MATH 340 or MATH 345) and (PH 122 or PH 142).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Credit not allowed for both BIOM 526 and ECE 526. Sections may be offered: Online.
**Term Offered:** Fall (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 527A Biosensing: Cells as Circuits Credit: 1 (1-0-0)**
**Also Offered As:** BIOM 527A.
**Course Description:** Treatment of biological cells as circuits and their electrical time-dependent function and frequency-dependent impedance. Topics include the Hodgkin–Huxley circuit model, diffusion equation, and modeling action potential propagation.
**Prerequisite:** (CHEM 111 or CHEM 120) and (LIFE 102) and (MATH 340 or MATH 345) and (PH 142).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527A, BIOM 581B1, ECE 527A, or ECE 581B1.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 527B Biosensing: Signal and Noise in Biosensors Credit: 1 (1-0-0)**
**Also Offered As:** BIOM 527B.
**Course Description:** Quantitative treatment of concepts of noise, interference and signal including noise types and spectra, filtering, and limitations imposed by noise. Example applications to Biosensors.
**Prerequisite:** (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently) and (PH 142).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527B, BIOM 581B2, ECE 527B, or ECE 581B2.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 527C Biosensing: Sensor Circuit Fundamentals Credit: 1 (1-0-0)**
**Also Offered As:** BIOM 527C.
**Course Description:** Introduction to circuit concepts used in sensors, including review of basic circuit elements of resistors, capacitors, and MOS (Metal-Oxide-Semiconductor transistors) elements. Fundamentals of the application of MOS circuits for signal conditioning and amplification and how sensor's backend signal processing is carried out after the sensor signal transduction stage.
**Prerequisite:** (ENGR 111 or LIFE 102) and (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527C, BIOM 581B3, ECE 527C, or ECE 581B3.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 527D Biosensing: Electrochemical Sensors Credit: 1 (1-0-0)**
**Also Offered As:** BIOM 527D.
**Course Description:** Introduction to the electrochemistry, and applications of electrochemical methods, used for detection of certain classes of chemicals and molecules.
**Prerequisite:** (ENGR 111 or LIFE 102) and (MATH 255 or MATH 261).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527D, BIOM 581B5, ECE 527D, or ECE 581B5.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 527E Biosensing: Affinity Sensors Credit: 1 (1-0-0)**
**Also Offered As:** BIOM 527E.
**Course Description:** Fundamentals of affinity sensor application and design, including optical and electrical approaches and technologies.
**Prerequisite:** (ENGR 111 or LIFE 102) and (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527E, BIOM 581B4, ECE 527E, or ECE 581B4.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 527F Biosensing: Biophotonic Sensors Using Refractive Index Credit: 1 (1-0-0)**
**Also Offered As:** BIOM 527F.
**Course Description:** Operating principles of optical biosensors based on changes in refractive index, such as thin films, ring-resonators, Mach-Zehnder interferometers, and other evanescent wave sensors. Basic supporting optical concepts, including thin-film interference, optical waveguides and evanescent waves.
**Prerequisite:** (BIOM 527E or ECE 527E) and (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently) and (PH 142).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527F, BIOM 581B6, ECE 527F, or ECE 581B6.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 528 Embedded Systems and Machine Learning Credits: 4 (3-2-0)**
**Also Offered As:** CS 528.
**Course Description:** Machine learning for embedded computing systems; hardware/software optimizations for machine learning; hardware accelerators for deep learning; data reuse and sharing techniques; memory and network design for machine learning acceleration; anomaly detection and adversarial learning; advanced applications of machine learning in embedded applications.
**Prerequisite:** CS 250 with a minimum grade of C or CS 270 with a minimum grade of C or ECE 251 with a minimum grade of C or ECE 253 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Must register for lecture and laboratory. Sections may be offered: Online. Credit allowed for only one of the following: CS 528, CS 581C1, ECE 528, or ECE 581C1.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 529 Signal Processing & Artificial Intelligence Credits: 3 (3-0-0)**
**Course Description:** Fundamentals of artificial intelligence (AI) and machine learning (ML) for signal processing applications. Combination of signal processing principles, programming, and human-centered design to create intelligent AI signal processing systems that can complete certain goals.
**Prerequisite:** ECE 312 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit not allowed for both ECE 529 and ECE 580C9.
**Term Offered:** Spring (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 532 Dynamics of Complex Engineering Systems Credits: 3 (3-0-0)**
**Also Offered As:** SYSE 532.
**Course Description:** Higher-level behavior and issues that emerge from interaction between components in complex socio-technical systems.
**Prerequisite:** ENGR 502, may be taken concurrently or ENGR 531, may be taken concurrently or SYSE 501, may be taken concurrently or SYSE 505, may be taken concurrently or SYSE 530, may be taken concurrently.
**Registration Information:** Sections may be offered: Online. Credit allowed for only one of the following: ECE 532, ENGR 532, or SYSE 532.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 534 Analog Integrated Circuit Design Credits: 4 (3-2-0)**
**Course Description:** Design methods for state-of-the-art analog integrated circuits including CMOS op-amps, comparators, and phase-locked loops.
**Prerequisite:** ECE 332 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Must register for lecture and laboratory.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 536 RF Integrated Circuit Design Credits: 3 (3-0-0)**
**Course Description:** Design of state-of-the-art ICs for RF applications including CMOS low-noise amplifiers, voltage-controlled oscillators, mixers and power amplifiers.
**Prerequisite:** ECE 332 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing. Sections may be offered: Online.
**Term Offered:** Fall (every third year).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 537 Biomedical Signal Processing Credits: 3 (3-0-0)**
**Also Offered As:** BIOM 537.
**Course Description:** Modeling and classification of biosignals (e.g. EEG, ECG, EMG), covering adaptive filtering, wavelets, support vector machines, neural networks, and handling problems with overfitting of noisy data.
**Prerequisite:** ECE 303 or ECE 311 or MATH 340 or STAT 303.
**Registration Information:** Sections may be offered: Online. Credit not allowed for both BIOM 537 and ECE 537.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 538 Design/Analysis of Analog Digital Interface Credits: 4 (3-3-0)**
**Course Description:** Topics of interface circuit designs analog and digital interfaces. Basic concept of designing and analyzing analog and digital interface circuits.
**Prerequisite:** ECE 312 with a minimum grade of C and ECE 332 with a minimum grade of C and ECE 451 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Must register for lecture and laboratory.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 539 Digital Communications Credits: 3 (3-0-0)**
**Course Description:** Signal space, optimal receiver design, waveform coding, and error correcting coding.
**Prerequisite:** ECE 303 with a minimum grade of C and ECE 312 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing. Sections may be offered: Online. Credit not allowed for both ECE 539 and ECE 614.
**Term Offered:** Spring (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 540 Computational Electromagnetics Credits: 3 (3-0-0)**
**Course Description:** Computational techniques for practical applications in electromagnetic fields, devices, scattering, propagation, and radiation.
**Prerequisite:** ECE 340 with a minimum grade of C or ECE 342 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 541 Applied Electromagnetics Credits: 3 (3-0-0)**
**Course Description:** High- and low-frequency electromagnetics, wave propagation, radiation, and scattering, wireless and guided-wave systems, bioelectromagnetics.
**Prerequisite:** ECE 340 with a minimum grade of C or ECE 342 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Credit not allowed for both ECE 541 and ECE 580B5.
**Term Offered:** Fall (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 544 Silicon Photonics for Computing Systems Credits: 3 (3-0-0)**
**Course Description:** Introduction to the modeling, analysis, design, and applications of silicon photonic devices and circuits.
**Prerequisite:** (PH 141) and (ECE 303 with a minimum grade of C or STAT 301 with a minimum grade of C or STAT 303 with a minimum grade of C or STAT 315 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit not allowed for both ECE 544 and ECE 580B6.
**Term Offered:** Fall.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 546 Laser Fundamentals and Devices Credits: 3 (3-0-0)**
**Course Description:** Amplification of light, laser excitation mechanisms, laser devices, characteristics and design.
**Prerequisite:** ECE 441.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing. Sections may be offered: Online.
**Term Offered:** Spring (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 548 Microwave Theory and Component Design Credits: 3 (3-0-0)**
**Course Description:** Fundamentals of microwave engineering, components, devices, and measurements.
**Prerequisite:** ECE 342 with a minimum grade of C.
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Spring (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 549 Radar Systems and Design Credits: 3 (3-0-0)**
**Course Description:** Fundamental ideas of radar operation and basic design of various radar types including current topics.
**Prerequisite:** ECE 312 with a minimum grade of C or ECE 340 with a minimum grade of C or ECE 342 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing. Sections may be offered: Online.
**Term Offered:** Spring (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 553 Adaptive Systems and Machine Learning Credits: 3 (3-0-0)**
**Course Description:** Adaptive system and machine learning algorithms. Topics include discriminants learning, pattern recognition, supervised and unsupervised learning, reinforcement learning, kernel machines for classification, regression, information retrieval, generative classifiers, deep learning machines, applications in adaptive controls and filters, signal processing, forecasting, and pattern recognition.
**Prerequisite:** (ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C) and (ECE 312 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit allowed for only one of the following: ECE 553, ECE 580C8, and ECE 656.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 554 Computer Architecture Credits: 3 (3-0-0)**
**Course Description:** Fundamentals of advanced computer architecture, AI and machine learning acceleration, multiprocessors and thread-level parallelism, memory systems, interconnection networks, and high performance computing.
**Prerequisite:** CS 470 or ECE 452.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing. Sections may be offered: Online.
**Term Offered:** Spring (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 555 Advanced Robotics—Redundancy & Optimization Credits: 3 (3-0-0)**
**Course Description:** Advanced analysis, design, and control of kinematically redundant articulated objects, including both robotic and biological systems.
**Prerequisite:** (ECE 455) and (DSCI 369 or MATH 369).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing.
**Term Offered:** Spring (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 556 AI for Radar and Remote Sensing Credits: 3 (3-0-0)**
**Course Description:** Radar and remote sensing using techniques from artificial intelligence (AI) and data science, with applications to areas such as precipitation observation, identification, classification, estimation, and prediction.
**Prerequisite:** (CS 150B with a minimum grade of C or CS 152 with a minimum grade of C or CS 162 with a minimum grade of C or CS 163 with a minimum grade of C or CS 164 with a minimum grade of C) and (ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit not allowed for both ECE 556 and ECE 580C3.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 559 Machine Learning in Imaging and Spectroscopy Credits: 3 (3-0-0)**
**Also Offered As:** BIOM 559.
**Course Description:** Investigate and critique applications of current techniques in biomedical imaging/spectroscopy such as convolutional networks to problems such as deconvolution, computed tomography, phase retrieval, hyperspectral unmixing, and learn how to apply these methods to datasets of their own. A special emphasis on biomedical imaging technologies and applications such as phase contrast microscopy, low-dose x-ray computed tomography, sparse fast magnetic resonance imaging, etc.
**Prerequisite:** (ECE 312 with a minimum grade of C or ECE 457) and (BIOM 403, may be taken concurrently or ECE 403, may be taken concurrently or ECE 441, may be taken concurrently or ECE 504) and (ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C or ECE 431 or BIOM 431) and (CS 150B with a minimum grade of C or CS 152 with a minimum grade of C or CS 163 with a minimum grade of C or CS 164 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit allowed for only one of the following: BIOM 559, BIOM 580C7, ECE 559, or ECE 580C7.
**Term Offered:** Fall (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 560 Foundations of Fine-Grain Parallelism Credits: 4 (3-2-0)**
**Also Offered As:** CS 560.
**Prerequisite:** CS 475.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 561 Hardware/Software Design of Embedded Systems Credits: 4 (3-3-0)**
**Also Offered As:** CS 561.
**Course Description:** Embedded systems design including system level modeling, design space exploration, hardware-software partitioning, high level synthesis.
**Prerequisite:** CS 250 with a minimum grade of C or CS 270 with a minimum grade of C or CS 470 or ECE 251 with a minimum grade of C or ECE 253 with a minimum grade of C or ECE 452.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Must register for lecture and laboratory. Junior standing. Sections may be offered: Online. Credit not allowed for both CS 561 and ECE 561.
**Term Offered:** Spring (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 562 Power Electronics I Credits: 3 (3-0-0)**
**Course Description:** Switch mode and resonant converters, control using switch averaged dynamic models, modeling of all circuit components including sources, loads, and switches.
**Prerequisite:** ECE 332 with a minimum grade of C.
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Spring (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 563 Introduction to Power System Markets Credits: 3 (3-0-0)**
**Course Description:** Economic theory and structure of market operations in deregulated electric power systems, with an emphasis on U.S. independent system operators (ISOs). Core topics include participant behavior in electric power markets, competitive auctions, system security and reliability, ancillary services, and investments in generation and transmission in addition to power system optimization, demand-side management, and calculation of carbon emissions.
**Prerequisite:** ECE 461.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit allowed for only one of the following: ECE 508, ENGR 508, ECE 563 or ECE 581C3.
**Term Offered:** Spring (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 564 Semiconductor Memory Credits: 3 (3-0-0)**
**Course Description:** Semiconductor memory technologies, following a bottom-up approach. Foundational design concepts of memory cells, reliability challenges within memory arrays, emerging security threats, and space radiation reliability concerns. Topics include mainstream memory technologies and emerging memory technologies.
**Prerequisite:** ECE 202 with a minimum grade of C or ECE 206 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit not allowed for both ECE 564 and ECE 580C6.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 565 Electrical Power Engineering Credits: 3 (3-0-0)**
**Also Offered As:** ENGR 565.
**Course Description:** Analysis of power systems in terms of current, voltage, and active/reactive power; introduction of computer-aided tools for power systems.
**Prerequisite:** (ECE 332 with a minimum grade of C) and (ECE 340 with a minimum grade of C or ECE 342 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Sections may be offered: Online. Credit not allowed for both ECE 565 and ENGR 565.
**Term Offered:** Fall (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 566 Grid Integration of Renewable Energy Systems Credits: 3 (3-0-0)**
**Course Description:** Integration of renewable energy systems including wind, solar, hydro, and other resources into electric power grids and microgrids. Topics include renewable resource modeling, power electronic interfaces, and the role of energy storage in system reliability and flexibility.
**Prerequisite:** ECE 461 or ECE 565.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing. Sections may be offered: Online.
**Term Offered:** Spring (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 568 Communication Systems in Smart Grids Credits: 3 (3-0-0)**
**Course Description:** Smart grid architectures, applications, requirements, and technical challenges from control and communication perspectives. How distributed generation, distribution systems, and smart loads impact grid operations and explore monitoring, control, and design methods to enhance smart grid performance and resilience.
**Prerequisite:** ECE 461.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit not allowed for both ECE 568 and ECE 581C4.
**Term Offered:** Spring (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 570 Microgrids Credits: 3 (3-0-0)**
**Course Description:** The fundamental concepts, architectures, modeling, and control of microgrids from both design and operational perspectives. Topics include distributed energy resource (DER) modeling with a focus on inverter-based sources, power flow, hierarchical control, and advanced techniques. Application of analytic methods and simulation tools such as MATLAB or PSCAD to study microgrid operation and control.
**Prerequisite:** ECE 461.
**Restriction:** Must not be a: Freshman, Sophomore, Junior.
**Registration Information:** Senior standing. Sections may be offered: Online.
**Term Offered:** Spring (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 571 VLSI System Design Credits: 4 (3-2-0)**
**Course Description:** Design of integrated circuits at the system level, including cell design, digital systems, parallel architecture, and systolic arrays.
**Prerequisite:** ECE 450 and ECE 451.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Must register for lecture and laboratory. Sections may be offered: Online.
**Term Offered:** Spring.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 572 Semiconductor Transistors Credit: 1 (1-0-0)**
**Course Description:** Quantitative analysis of electric field, carrier and current distributions in MOSFETs and bipolar junction transistors; scaling, non-idealities.
**Prerequisite:** (ECE 331 with a minimum grade of C) and (ECE 415, may be taken concurrently or ECE 471B).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** This is a partial semester course. Junior standing.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 573 Semiconductor Optoelectronics Laboratory Credits: 3 (1-4-0)**
**Course Description:** Experimental characterization techniques for semiconductor optoelectronic devices and design and testing of related electronic circuits.
**Prerequisite:** ECE 415.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Must register for lecture and laboratory.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 574 Optical Properties in Solids Credits: 3 (3-0-0)**
**Course Description:** Light propagation and interaction with materials; linear and non-linear optical properties.
**Prerequisite:** ECE 441 with a minimum grade of C.
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior Standing. Sections may be offered: Online.
**Term Offered:** Spring (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 578 Satellite Data Analysis Credits: 3 (3-0-0)**
**Course Description:** Broad exposure to a variety of traditional and modern statistical methods for filtering and analyzing satellite data and imagery. Topics include fundamentals in statistics, time-series analysis, filter design, image processing techniques, spatial analysis of data fields such as principal component analysis, cluster analysis, etc. Solve common data analysis problems in satellite remote sensing.
**Prerequisite:** (ECE 303 with a minimum grade of C or STAT 301 with a minimum grade of C or STAT 303 with a minimum grade of C or STAT 315 with a minimum grade of C) and (ECE 311 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online.
**Term Offered:** Fall (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 579 Global Navigation Satellite Systems Credits: 3 (3-0-0)**
**Course Description:** Provides a fundamental understanding of Global Navigation Satellite Systems (GNSS), including GNSS satellite constellations, satellite orbits, ground monitoring stations functions, GNSS receivers, GNSS measurement errors and correction techniques, recent advancements in GPS and other international GNSS, and applications of GNSS. Learn to use a variety of GNSS receivers to collect data, to compute receiver position, velocity, and time, and to analyze GNSS data.
**Prerequisite:** (CS 150B with a minimum grade of C or CS 152 with a minimum grade of C or CS 162 with a minimum grade of C or CS 163 with a minimum grade of C or CS 164 with a minimum grade of C) and (ECE 311 with a minimum grade of C and MATH 261 with a minimum grade of C and PH 142 with a minimum grade of C).
**Restriction:** Must not be a: Freshman, Sophomore.
**Registration Information:** Junior standing. Sections may be offered: Online. Credit not allowed for both ECE 579 and ECE 580C5.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 587 Internship Credits: Var[1-6] (0-0-0)**
**Course Description:** Internship experience in Electrical or Computer Engineering.
**Prerequisite:** ECE 312 or ECE 456.
**Registration Information:** Graduate standing.
**Terms Offered:** Fall, Spring, Summer.
**Grade Mode:** S/U Sat/Unsat Only.
**Special Course Fee:** No.

**ECE 604 Nonlinear Optics Credits: 3 (3-0-0)**
**Course Description:** Principles of nonlinear optics, symmetry properties, multiple order nonlinear phenomenon, and nonlinear spectroscopy.
**Prerequisite:** ECE 504 and PH 451.
**Restriction:** Must be a: Graduate, Professional.
**Registration Information:** Sections may be offered: Online.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 611 Nonlinear Control Systems Credits: 3 (3-0-0)**
**Course Description:** Controller analysis and design for nonlinear systems.

**Prerequisite:** ECE 412.
**Restriction:** Must be a: Graduate, Professional.
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Fall (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 641 Electromagnetics Credits: 3 (3-0-0)**
**Course Description:** Electrostatics, magnetostatics, boundary value problems, EM induction, quasi-statics, Maxwell's equations.
**Prerequisite:** ECE 342.
**Restriction:** Must be a: Graduate, Professional.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 650 Extreme Ultraviolet and Soft X-Ray Radiation Credits: 3 (3-0-0)**
**Course Description:** Fundamental principles of short wavelength electromagnetic radiation.
**Prerequisite:** ECE 342.
**Restriction:** Must be a: Graduate, Professional.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 652 Estimation and Filtering Theory Credits: 3 (3-0-0)**
**Course Description:** Linear and Nonlinear parameter and state estimation methods; Optimal Kalman state estimation and applications.
**Prerequisite:** ECE 514 or STAT 525.
**Restriction:** Must be a: Graduate, Professional.
**Registration Information:** Sections may be offered: Online.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 653 Detection Theory Credits: 3 (3-0-0)**
**Course Description:** Neyman-Pearson and Bayes detectors and properties, matched filter and matched subspace detectors, distributed detection, and applications.
**Prerequisite:** ECE 652.
**Restriction:** Must be a: Graduate, Professional.
**Registration Information:** Sections may be offered: Online. Credit not allowed for both ECE 651 and ECE 653.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 658 Internet Engineering Credits: 4 (3-3-0)**
**Also Offered As:** CS 658.
**Course Description:** Link technologies, multiple access, hardware and software for internetworks routing, switching flow control, multicast, performance, and applications.
**Prerequisite:** ECE 456 or CS 457.
**Restriction:** Must be a: Graduate, Professional.
**Registration Information:** Must register for lecture and laboratory. Sections may be offered: Online. Credit not allowed for both ECE 658 and CS 658.
**Term Offered:** Fall (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 666 Topics in Robotics Credits: 3 (3-0-0)**
**Course Description:** Recent advances in robotics, automation, and intelligent systems.
**Prerequisite:** ECE 455.
**Restriction:** Must be a: Graduate, Professional.
**Term Offered:** Spring (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 669 Emerging Topics in AI for Power Systems Credits: 3 (3-0-0)**
**Course Description:** Recent advances in applications of artificial intelligence in electric power and energy systems. Emphasis is placed on applying modern AI techniques to problems in power system operations, optimization, stability, markets, and resilience. Critically assess state-of-the-art literature and develop methods for grid modernization challenges.
**Prerequisite:** ECE 565 or ECE 566 or ECE 568 or ECE 570.
**Restriction:** Must be a: Graduate, Professional.
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Fall (even years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 673 Thin Film Growth Credits: 3 (3-0-0)**
**Course Description:** Fundamentals of thin film growth including the growth of amorphous oxide thin films in the context of the engineering of interference coatings. Fundamentals of the metrology used to diagnose the structural and optical properties of the thin films.
**Prerequisite:** None.
**Restriction:** Must be a: Graduate, Professional.
**Registration Information:** Sections may be offered: Online.
**Term Offered:** Spring (odd years).
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 695 Independent Study Credits: Var[1-18] (0-0-0)**
**Course Description:**
**Prerequisite:** None.
**Restriction:** Must be a: Graduate, Professional.
**Terms Offered:** Fall, Spring, Summer.
**Grade Mode:** Instructor Option.
**Special Course Fee:** No.

**ECE 697 Group Study Credits: Var[1-6] (0-0-0)**
**Also Offered As:** ENGR 697.
**Course Description:**
**Prerequisite:** None.
**Restriction:** Must be a: Graduate, Professional.
**Registration Information:** Credit not allowed for both ECE 697 and ENGR 697.
**Terms Offered:** Fall, Spring, Summer.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 699 Thesis Credits: Var[1-18] (0-0-0)**
**Course Description:**
**Prerequisite:** None.
**Restriction:** Must be a: Graduate, Professional.
**Terms Offered:** Fall, Spring, Summer.
**Grade Mode:** Instructor Option.
**Special Course Fee:** No.

**ECE 742 Topics in Electromagnetics Credits: 3 (3-0-0)**
**Course Description:** Applications of wave propagation and scattering to microwave radar, Doppler radar, meteorological radar applications.
**Prerequisite:** ECE 641.
**Restriction:** Must be a: Graduate, Professional.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 752 Topics in Signal Processing Credits: 3 (3-0-0)**
**Course Description:** Adaptive filtering, spectral estimation, sonar/radar signal processing, and detection/classification schemes.
**Prerequisite:** (ECE 512) and (ECE 514 or STAT 525).
**Restriction:** Must be a: Graduate, Professional.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 777 X-Ray Lasers Credits: 3 (3-0-0)**
**Course Description:** Fundamentals, design, and implementation of soft X-ray lasers and X-ray optics.
**Prerequisite:** ECE 546.
**Restriction:** Must be a: Graduate, Professional.
**Grade Mode:** Traditional.
**Special Course Fee:** No.

**ECE 795 Independent Study Credits: Var[1-18] (0-0-0)**
**Course Description:**
**Prerequisite:** None.
**Restriction:** Must be a: Graduate, Professional.
**Terms Offered:** Fall, Spring, Summer.
**Grade Mode:** Instructor Option.
**Special Course Fee:** No.

**ECE 799 Dissertation Credits: Var[1-18] (0-0-0)**
**Course Description:**
**Prerequisite:** None.
**Restriction:** Must be a: Graduate, Professional.
**Terms Offered:** Fall, Spring, Summer.
**Grade Mode:** Instructor Option.
**Special Course Fee:** No.