Electrical Engineering & Computer Science (EECS)

Courses

EECS 1. Introduction to Electrical Engineering and Computer Engineering. 1 Unit.
Introduction to the fields of Electrical Engineering and Computer Engineering, including possible careers in both traditional and new emerging areas. Background on both the Electrical Engineering and the Computer Engineering majors, curriculum requirements, specializations, and faculty research interests.

(Design units: 0)

Restriction: Electrical Engineering Majors have first consideration for enrollment.

EECS 10. Computational Methods in Electrical and Computer Engineering. 4 Units.
An introduction to computers and structured programming. Binary Data Representation. Hands-on experience with a high-level structured programming language. Introduction to algorithm efficiency. Applications of structured programming in solving engineering problems. Programming laboratory.

(Design units: 0)

Corequisite: MATH 2A
Prerequisite: MATH 2A or AP Calculus AB. AP Calculus AB with a minimum score of 3

Overlaps with EECS 12.

Restriction: Chemical Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment.

EECS 12. Introduction to Programming. 4 Units.
An introduction to computers and programming. Python programming syntax/style, types. Numbers and sequences. Control flow. I/O and errors/exceptions. Function calling, parameter passing, formal arguments, return values. Variable scoping. Programming laboratory.

(Design units: 0)

Corequisite: MATH 2A
Prerequisite: MATH 2A or AP Calculus AB. AP Calculus AB with a minimum score of 3

Overlaps with EECS 10.

Restriction: Computer Engineering Majors have first consideration for enrollment.

EECS 20. Computer Systems and C Programming. 4 Units.
Introduction to computing systems. Data representation and operations. Simple logic design. Basic computer organization. Instruction set architecture and assembly language programming. Introduction to C. Functions and recursion, data structures, pointers. Programming laboratory.

(Design units: 1)

Prerequisite: EECS 12

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 22. Advanced C Programming. 3 Units.
C language programming concepts. Control flow, function calls, recursion. Basic and composite data types, static and dynamic data structures. Program modules and compilation units. Preprocessor macros. C standard libraries.

(Design units: 1)

Prerequisite: EECS 10 or EECS 20

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 22L. Software Engineering Project in C Language. 3 Units.
Hands-on experience with the ANSI-C programming language. Medium-sized programming projects, team work. Software specification, documentation, implementation, testing. Definition of data structures and application programming interface. Creation of program modules, linking with external libraries. Rule-based compilation, version control.

(Design units: 3)

Prerequisite: EECS 22

Restriction: Computer Engineering Majors have first consideration for enrollment.

EECS 31. Introduction to Digital Systems. 4 Units.
Digital representation of information. Specification, analysis, design and optimization or combinational and sequential logic, register-transfer components and register-transfer systems with datapaths and controllers. Introduction to high-level and algorithmic state-machines and custom processors.

(Design units: 2)

Prerequisite: I&C SCI 31 or EECS 10 or EECS 12 or ENGRMAE 10 or I&C SCI 32A

Restriction: Computer Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment.

EECS 31L. Introduction to Digital Logic Laboratory. 3 Units.
Introduction to common digital integrated circuits: gates, memory circuits, MSI components. Operating characteristics, specifications, applications. Design of simple combinational and sequential digital systems (arithmetic processors game-playing machines). Construction and debugging techniques using hardware description languages and CAD tools.

(Design units: 3)

Prerequisite: EECS 31 and (EECS 10 or EECS 12 or I&C SCI 32)

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 40. Object-Oriented Systems and Programming. 4 Units.
Primitive types and expressions. The class and method definition. Information hiding and encapsulation. Objects and reference. Overloading. Constructors. Inheritance basics. Programming with inheritance. Dynamic binding and polymorphism. Exception handling. An overview of streams and file input/output. Programming laboratory.

(Design units: 2)

Prerequisite: EECS 22L

Restriction: Computer Engineering Majors have first consideration for enrollment.

EECS 50. Discrete-Time Signals and Systems. 4 Units.
Analysis of discrete-time linear-time-invariant (DTLTI) systems in the time domain and using z-transforms. Introduction to techniques based on Discrete-Time, Discrete, and Fast Fourier Transforms. Examples of their application to digital signal processing and digital communications.

(Design units: 0)

Prerequisite: EECS 70A

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 55. Engineering Probability. 4 Units.
Sets and set operations; nature of probability, sample spaces, fields of events, probability measures; conditional probability, independence, random variables, distribution functions, density functions, conditional distributions and densities; moments, characteristic functions, random sequences, independent and Markov sequences.

(Design units: 0)

Prerequisite: MATH 2D

Restriction: Computer Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment.

EECS 70A. Network Analysis I. 4 Units.
Modeling and analysis of electrical networks. Basic network theorems. Sinusoidal steady state and transient analysis of RLC networks and the impedance concept.

(Design units: 1)

Corequisite: MATH 3D
Prerequisite: PHYSICS 7D and (EECS 10 or EECS 12 or ENGRMAE 10 or I&C SCI 31 or ENGRCEE 20)

Overlaps with ENGRMAE 60.

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Mechanical Engineering Majors have first consideration for enrollment. Aerospace Engineering Majors have first consideration for enrollment. Civil Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment. Environmental Engineering Majors have first consideration for enrollment.

EECS 70B. Network Analysis II. 4 Units.
Laplace transforms, complex frequency, and the s-plane. Network functions and frequency response, including resonance. Bode plots. Two-port network characterization.

(Design units: 1)

Corequisite: EECS 70LB
Prerequisite: (BME 60B or EECS 10 or EECS 12 or I&C SCI 31 or ENGRCEE 20 or ENGRMAE 10) and EECS 70A

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment.

EECS 70LA. Network Analysis I Laboratory. 1 Unit.
Laboratory to accompany EECS 70A.

(Design units: 0)

Corequisite: EECS 70A
Prerequisite: PHYSICS 7D and (EECS 10 or EECS 12 or BME 60B or ENGRCEE 20 or ENGRMAE 10)

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 70LB. Network Analysis II Laboratory. 1 Unit.
Laboratory to accompany EECS 70B. Materials fee.

(Design units: 1)

Corequisite: EECS 70B
Prerequisite: (BME 60B or EECS 10 or EECS 12 or I&C SCI 31 or ENGRCEE 20 or ENGRMAE 10) and EECS 70A

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 101. Introduction to Machine Vision. 3 Units.
The use of digital computers for the analysis of visual scenes; image formation and sensing, color, segmentation, shape estimation, motion, stereo, pattern classification, computer architectures, applications. Computer experiments are used to illustrate fundamental principles.

(Design units: 2)

Prerequisite: EECS 150 or EECS 50

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 111. System Software. 4 Units.
Multiprogramming, interrupt, processes, kernel, parallelism, critical sections, deadlocks, communication, multiprocessing, multilevel memory management, binding, name management, file systems, protection, resource allocation, scheduling. Experience with concurrent programming, synchronization mechanisms, interprocess communication.

(Design units: 2)

Prerequisite: EECS 112 and (I&C SCI 46 or EECS 114)

Overlaps with COMPSCI 143A.

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 112. Organization of Digital Computers. 4 Units.
Building blocks and organization of digital computers, the arithmetic, control, and memory units, and input/out devices and interfaces. Microprogramming and microprocessors.

(Design units: 4)

Prerequisite: EECS 31L

Overlaps with COMPSCI 152.

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 112L. Organization of Digital Computers Laboratory. 3 Units.
Specification and implementation of a processor-based system using a hardware description language such as VHDL. Hands-on experience with design tools including simulation, synthesis, and evaluation using testbenches.

(Design units: 3)

Prerequisite: EECS 112

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 113. Processor Hardware/Software Interfaces. 4 Units.
Hardware/software interfacing, including memory and bus interfaces, devices, I/O, and compiler code generation/instruction scheduling. Experience microcontroller programming and interfacing. Specific compiler code generation techniques including local variable and register allocations, instruction dependence and scheduling, and code optimization.

(Design units: 3)

Prerequisite: EECS 112

Restriction: Computer Engineering Majors have first consideration for enrollment. Computer Science and Engineering Majors have second consideration for enrollment.

EECS 114. Engineering Data Structures and Algorithms. 4 Units.
Introduces abstract behavior of classes data structures, alternative implementations, informal analysis of time and space efficiency. Also introduces classic algorithms and efficient algorithm design techniques (recursion, divide-and-conquer, branch-and-bound, dynamic programming).

(Design units: 2)

Prerequisite: EECS 40

Restriction: Computer Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 116. Introduction to Data Management. 4 Units.
Introduction to the design of databases and the use of database management systems (DBMS) for applications. Topics include entity-relationship modeling for design, relational data model, relational algebra, relational design theory, and Structured Query Language (SQL) programming.

(Design units: 1)

Prerequisite: I&C SCI 33 or EECS 114. I&C SCI 33 with a grade of C or better

Same as COMPSCI 122A.

Restriction: School of Info & Computer Sci students have first consideration for enrollment. Computer Science Engineering Majors have first consideration for enrollment.

EECS 117. Parallel Computer Systems. 3 Units.
General introduction to parallel computing focusing on parallel algorithms and architectures. Parallel models: Flynn's taxonomy, dataflow models. Parallel architectures: systolic arrays, hypercube architecture, shared memory machines, dataflow machines, reconfigurable architectures. Parallel algorithms appropriate to each machine type area also discussed.

(Design units: 1)

Prerequisite: EECS 20 and EECS 114 and EECS 112

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 118. Data and Knowledge Science and Engineering. 4 Units.
Introduction of basic concepts in artificial intelligence. Knowledge representation and reasoning, search, planning, declarative programing, problem solving, and data science.

(Design units: 2)

Prerequisite: EECS 114

Overlaps with COMPSCI 171.

Restriction: Computer Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 119. VLSI. 4 Units.
Design techniques for Very Large Scale Integrated (VLSI) systems and chips. Review CMOS and related process technologies; primitives such as logic gates and larger design blocks; layout; floor planning; design hierarchy, component interfaces; use of associated CAD tools for design.

(Design units: 4)

Prerequisite: EECS 112 and EECS 170B

Overlaps with EECS 170D, CSE 112.

Restriction: Computer Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 120. Fundamentals of Parallel Computing. 4 Units.
Fundamentals of parallel computing, focusing on parallel algorithms and architectures. Topics include design of parallel and I/O efficient algorithms, basics of parallel machine architectures, and current/emerging programming models (shared memory, distributed memory, and accelerators).

Prerequisite: (EECS 12 or COMPSCI 152) and EECS 114

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 121. System Security. 3 Units.
Fundamentals and practices of system security. Topics include cryptographic (encryption, decryption, and message authentication), software vulnerabilities (buffer overflow), network security (layer 2-7 attacks and defenses and PKI), web security (XSS and XSRF), and privacy.

Prerequisite: EECS 22 or I&C SCI 45C

EECS 125. Introduction to Machine Learning for Engineers. 4 Units.
Introduction to ML with a special focus on engineering applications. Starts with a mathematical background required for ML and covers various models for supervised learning (classification and regression) and unsupervised learning (clustering).

Prerequisite: EECS 55 and EECS 145 and EECS 12. Recommended: EECS 114.

Overlaps with COMPSCI 178.

EECS 141A. Communication Systems I. 3 Units.
Introduction to analog communication systems including effects of noise. Modulation-demodulation for AM, DSB-SC, SSB, VSB, QAM, FM, PM, and PCM with application to radio, television, and telephony. Signal processing as applied to communication systems.

(Design units: 1)

Prerequisite: EECS 55 and EECS 150

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 141B. Communication Systems II. 3 Units.
Signal space analysis. Optimum receivers for digital communication. Maximum a posteriori and maximum likelihood detection. Matched filter and correlation receiver. PAM, QAM, PSK, FSK, and MSK and their performance. Introduction to equalization, synchronization, information theory, and error control codes.

(Design units: 1)

Prerequisite: EECS 141A

Restriction: Computer Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have first consideration for enrollment.

EECS 144. Antenna Design for Wireless Communication Links. 4 Units.
Analysis and synthesis of antennas and antenna arrays. Adaptive arrays and digital beam forming for advanced wireless links. Friis transmission formula. Wireless communication equations for cell-site and mobile antennas, interference, slow and fast fading in mobile communication.

(Design units: 0)

Prerequisite: EECS 180A

EECS 145. Electrical Engineering Analysis. 4 Units.
Vector calculus, complex functions, and linear algebra with applications to electrical engineering problems.

(Design units: 0)

Prerequisite: MATH 3D

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment. Computer Science Engineering majors have second consideration for enrollment.

EECS 148. Computer Networks. 4 Units.
Computer network architectures, protocols, and applications. Internet congestion control, addressing, and routing. Local area networks. Multimedia networking.

(Design units: 2)

Prerequisite: EECS 55 or STATS 67

Same as COMPSCI 132.

Restriction: Computer Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have first consideration for enrollment.

EECS 150. Continuous-Time Signals and Systems. 4 Units.
Characteristics and properties of continuous-time (analog) signals and systems. Analysis of linear time-invariant continuous-time systems using differential equation convolutional models. Analysis of these systems using Laplace transforms, Fourier series, and Fourier transforms. Examples from applications to telecommunications.

(Design units: 0)

Prerequisite: EECS 70A and MATH 3D

Restriction: Computer Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 152A. Digital Signal Processing. 3 Units.
Nature of sampled data, sampling theorem, difference equations, data holds, z-transform, w-transform, digital filters, Butterworth and Chebychev filters, quantization effects.

(Design units: 2)

Prerequisite: EECS 50

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 152B. Digital Signal Processing Design and Laboratory. 3 Units.
Design and implementation of algorithms on a DSP processor and using computer simulation. Applications in signal and image processing, communications, radar, etc.

(Design units: 3)

Prerequisite: EECS 152A

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 159A. Senior Design Project I. 3 Units.
Teaches problem definition, detailed design, integration, and testability with teams of students specifying, designing, building, and testing complex systems. Lectures include engineering values, discussions, and ethical ramifications of engineering decisions.

(Design units: 3)

Prerequisite: EECS 113 or EECS 170C or COMPSCI 145

Restriction: Seniors only. Computer Science Engineering Majors only. Electrical Engineering Majors only. Computer Engineering Majors only.

EECS 159B. Senior Design Project II. 3 Units.
Teaches problem definition, detailed design, integration, and testability with teams of students specifying, designing, building, and testing complex systems. Lectures include engineering values, discussions, and ethical ramifications of engineering decisions. Materials fee.

(Design units: 3)

Prerequisite: EECS 159A

Restriction: Computer Science Engineering Majors only. Electrical Engineering Majors only. Computer Engineering Majors only.

EECS 160A. Introduction to Control Systems. 4 Units.
Modeling, stability, and specifications of feedback control systems. Root locus, Bode plots, Nyquist criteria, and state-space methods for dynamic analysis and design.

(Design units: 2)

Corequisite: EECS 160LA
Prerequisite: (EECS 10 or EECS 12 or ENGRMAE 10 or BME 60B or ENGRCEE 20) and EECS 150 and EECS 170B and EECS 170LB

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 160LA. Control Systems I Laboratory. 1 Unit.
Laboratory accompanying EECS 160A. Materials fee.

(Design units: 1)

Corequisite: EECS 160A

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 163. Power Systems. 4 Units.
Generation, transmission, and use of electrical energy. Fault calculation, protection, stability, and power flow.

(Design units: 1)

Corequisite: EECS 163L
Prerequisite: EECS 70B

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 163L. Power Systems Laboratory. 1 Unit.
Experiments and field trips relevant to studies in power systems. Materials fee.

(Design units: 0)

Corequisite: EECS 163

Restriction: Computer Science Engineering Majors only. Electrical Engineering Majors only. Computer Engineering Majors only.

EECS 166A. Industrial and Power Electronics. 4 Units.
Power switching devices, pulse width modulation (PWM) methods, switching converter topologies, control, and magnetics. Materials fee.

(Design units: 2)

Prerequisite: EECS 170C and EECS 160A

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have second consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

Concurrent with EECS 267A.

EECS 170A. Electronics I. 4 Units.
The properties of semiconductors, electronic conduction in solids, the physics and operation principles of semiconductor devices such as diodes and transistors, transistor equivalent circuits, and transistor amplifiers.

(Design units: 1)

Corequisite: PHYSICS 7E
Prerequisite: PHYSICS 7D and EECS 70B

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 170B. Electronics II. 4 Units.
Design and analysis of single-stage amplifiers, biasing circuits, inverters, logic gates, and memory elements based on CMOS transistors.

(Design units: 2)

Corequisite: EECS 170LB
Prerequisite: EECS 70B and EECS 170A and EECS 170LA

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 170C. Electronics III. 4 Units.
Principles of operation, design, and utilization of integrated circuit modules, including multi-stage amplifiers, operational amplifiers, and logic circuits.

(Design units: 2)

Corequisite: EECS 170LC
Prerequisite: EECS 170B and EECS 170LB

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have second consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 170D. Integrated Electronic Circuit Design. 4 Units.
Design and fabrication of modern digital integrated circuits. Fabrication of CMOS process, transistor-level design simulation, functional characteristics of basic digital integrated circuits, and different logic families including the static and dynamic logic, layout, and extraction of digital circuits.

(Design units: 4)

Prerequisite: EECS 170C and EECS 170LC

Overlaps with EECS 119, CSE 112.

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have second consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 170E. Analog and Communications IC Design. 4 Units.
Advanced topics in design of analog and communications integrated circuits. Topics include: implementation of passive components in integrated circuits; overview of frequency response of amplifiers, bandwidth estimation techniques, high-frequency amplifier design; design of radio-frequency oscillators.

(Design units: 3)

Prerequisite: EECS 170C

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have second consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 170LA. Electronics I Laboratory. 1 Unit.
Laboratory accompanying EECS 170A to perform experiments on semiconductor material properties, semiconductor device physics and operation principles, and transistor amplifiers to improve experimental skills and to enhance the understanding of lecture materials.

(Design units: 1)

Corequisite: EECS 170A and PHYSICS 7E
Prerequisite: PHYSICS 7D and EECS 70B

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment.

EECS 170LB. Electronics II Laboratory. 1 Unit.
Laboratory accompanying EECS 170B.

(Design units: 1)

Corequisite: EECS 170B
Prerequisite: EECS 170A and EECS 170LA

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 170LC. Electronics III Laboratory. 1 Unit.
Laboratory accompanying EECS 170C to provide hands-on training in design of digital/analog circuits/subsystems. Materials fee.

(Design units: 1)

Corequisite: EECS 170C
Prerequisite: EECS 170B and EECS 170LB

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have second consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 174. Semiconductor Devices. 4 Units.
Metal-semiconductor junctions, diodes, bipolar junction transistors, MOS structures, MOSFETs, CMOS technology, LEDs, and laser diodes.

(Design units: 1)

Prerequisite: EECS 170A

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment. Materials Science Engineering Majors have second consideration for enrollment.

EECS 176. Fundamentals of Solid-State Electronics and Materials. 4 Units.
Physical properties of semiconductors and the roles materials play in device operation. Topics include: crystal structure, phonon vibrations, energy band, transport phenomenon, optical properties and quantum confinement effect essential to the understanding of electronic, optoelectronic and nanodevices.

(Design units: 1)

Prerequisite: EECS 170A

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment.

EECS 179. Microelectromechanical Systems (MEMS). 4 Units.
Small-scale machines, small-scale phenomena, MEMS fabrication, MEMS CAD tools, MEMS devices and packaging, MEMS testing.

(Design units: 2)

Restriction: Upper-division students only. Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment.

EECS 180A. Engineering Electromagnetics I. 4 Units.
Electrostatics, magnetostatics, and electromagnetic fields: solutions to problems in engineering applications; transmission lines, Maxwell's equations and phasors, plane wave propagation, reflection, and transmission.

(Design units: 1)

Prerequisite: PHYSICS 7E and EECS 145

Restriction: Electrical Engineering Majors have first consideration for enrollment. Biomedical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.

EECS 180B. Engineering Electromagnetics II. 4 Units.
Time-varying electromagnetic fields, plane waves, polarization, guidance of waves like rectangular waveguides and microstrips, optical fibers resonant cavities, skin effects and losses, spherical waves, radiation and reception of waves, antenna basics.

(Design units: 1)

Prerequisite: EECS 180A

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 182. Monolithic Microwave Integrated Circuit (MMIC) Analysis and Design. 4 Units.
Design of microwave amplifiers including low-noise amplifiers, multiple stage amplifiers, power amplifiers, and introduction to broadband amplifiers. The goal is to provide the basic knowledge for the design of microwave amplifiers ranging from wireless system to radar system.

(Design units: 3)

Prerequisite: EECS 180A

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment.

EECS 188. Optical Electronics. 4 Units.
Photodiodes and optical detection, photometry and radiometry, geometric optics, lens theory, imaging system, EM wave propagation, optical waveguides and fibers, heterojunction structures, laser theory, semiconductor lasers, and optical transmission system.

(Design units: 1)

Prerequisite: EECS 180A

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have second consideration for enrollment.

EECS 195. Special Topics in Electrical and Computer Engineering. 1-4 Units.
Studies special topics in selected areas of Electrical and Computer Engineering. Topics addressed vary each quarter.

(Design units: 1-4)

Prerequisite: Prerequisites vary.

Repeatability: Unlimited as topics vary.

EECS 197. Electrical Engineering and Computer Science Internship. 2-12 Units.
Students majoring in EECS may receive credit for an approved internship, working at a company under the supervision of an industry mentor and a faculty advisor. Enables students to gain valuable experience in a professional setting and enhance their skills.

Grading Option: Pass/no pass only.

Repeatability: May be taken for credit 3 times.

EECS 198. Group Study. 1-4 Units.
Group study of selected topics in Electrical and Computer Engineering.

(Design units: 1-4)

Repeatability: May be repeated for credit unlimited times.

Restriction: Upper-division students only.

EECS 199. Individual Study. 1-4 Units.
For undergraduate Engineering majors in supervised but independent reading, research, or design. Students taking Individual study for design credit are to submit a written paper to the instructor and to the Undergraduate Student Affairs Office in the School of Engineering.

(Design units: 1-4)

Repeatability: May be taken for credit for 8 units.

EECS 199P. Individual Study. 1-4 Units.
For undergraduate Engineering majors in supervised but independent reading, research, or design. Students taking individual study for design credit are to submit a written paper to the instructor and to the Student Affairs Office in the School of Engineering.

(Design units: 1-4)

Grading Option: Pass/no pass only.

Repeatability: May be repeated for credit unlimited times.

EECS 202P. Techniques in Medical Imaging: X-ray, Nuclear, and NMR Imaging. 4 Units.
Ionizing radiation, planar and tomographic radiographic and nuclear imaging, magnetism, NMR, MRI imaging.

Restriction: Master of Engineering students only. Graduate students only.

EECS 203A. Digital Image Processing. 4 Units.
Pixel-level digital image representation and elementary operations; Fourier and other unitary transforms; compression, enhancement, filtering, and restoration; laboratory experience is provided.

Restriction: Graduate students only.

EECS 203P. Digital Image Processing. 4 Units.
Pixel-level digital image representation and elementary operations; Fourier and other unitary transforms; compression, enhancement, filtering, and restoration; laboratory experience is provided.

Restriction: Master of Engineering students only. Graduate students only.

EECS 204P. Personalized Medical Devices. 4 Units.
Introduces students to fundamental aspects of medical devices and discusses therapeutic as well as diagnostic devices. Basic aspects of microfluidics and biology critical to personalized medical systems are studied. Typical FDA approval pathways for medical devices are presented.

Same as ENGRMAE 204P.

Restriction: Master of Engineering students only.

Concurrent with BME 204P.

EECS 211. Advanced System Software. 4 Units.
Study of operating systems including interprocess communication, scheduling, resource management, concurrency, reliability, validation, protection and security, and distributed computing support. System software design languages and modeling analysis.

Restriction: Graduate students only.

EECS 211P. Advanced System Software. 4 Units.
Study of operating systems including interprocess communication, scheduling, resource management, concurrency, reliability, validation, protection and security, and distributed computing support. System software design languages and modeling analysis.

Prerequisite: Recommended: Undergraduate-level knowledge of system software (e.g. EECS 111) and organization of digital computers (e.g. UCI EECS 112).

Restriction: Master of Engineering students only. Graduate students only.

EECS 213. Computer Architecture. 4 Units.
Problems in hardware, firmware (microprogram), and software. Computer architecture for resource sharing, real-time applications, parallelism, microprogramming, and fault tolerance. Various architectures based on cost/performance and current technology.

Restriction: Graduate students only.

EECS 213P. Computer Architecture. 4 Units.
Problems in hardware, firmware (microprogram), and software. Computer architecture for resource sharing, real-time applications, parallelism, microprogramming, and fault tolerance. Various architectures based on cost/performance and current technology.

Prerequisite: Recommended: Undergraduate-level knowledge of organization of digital computers (e.g. EECS 112 and EECS 112L).

Restriction: Master of Engineering students only. Graduate students only.

EECS 215. Design and Analysis of Algorithms. 4 Units.
Computer algorithms from a practical standpoint. Algorithms for symbolic and numeric problems such as sorting, searching, graphs, and network flow. Analysis includes algorithm time and space complexity.

EECS 215P. Design and Analysis of Algorithms. 4 Units.
Computer algorithms from a practical standpoint. Algorithms for symbolic and numeric problems such as sorting, searching, graphs, and network flow. Analysis includes algorithm time and space complexity.

Restriction: Master of Engineering students only. Graduate students only.

EECS 216. Advanced Application of Algorithms. 4 Units.
Medium-sized group and individual programming project. Topics include specification requirements documentation, practical implementation of algorithms, and testing/verification of design.

Prerequisite: Recommended: Undergraduate course work in engineering data structures and algorithms.

EECS 217. VLSI System Design. 4 Units.
Overview of integrated fabrication, circuit simulation, basic device physics, device layout, timing; MOS logic design; layout generation, module generation, techniques for very large scale integrated circuit design.

Restriction: Graduate students only.

EECS 217P. VLSI System Design. 4 Units.
Overview of integrated fabrication, circuit simulation, basic device physics, device layout, timing; MOS logic design; layout generation, module generation, techniques for very large scale integrated circuit design.

Prerequisite: Recommended: Undergraduate-level knowledge of organization of digital computers (e.g. EECS 112).

Restriction: Master of Engineering students only. Graduate students only.

EECS 220P. Advanced Digital Signal Processing Architecture. 4 Units.
Study the latest DSP architectures for applications in communication (wired and wireless) and multimedia processing. Emphasis given to understanding the current design techniques and to evaluate the performance, power, and application domain of the latest DSP processors.

Prerequisite: EECS 213P. EECS 213P with a grade of B- or better

Restriction: Graduate students only. Master of Engineering students only.

EECS 221. Topics in Computer Engineering. 4 Units.
New research results in computer engineering.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EECS 222. Embedded System Modeling. 4 Units.
Computational models for embedded systems. System-level specification and description languages. Concepts, requirements, examples. Embedded system models at different levels of abstraction. Modeling of test benches, design under test, IP components. Discrete event simulation, semantics, and algorithms. Formerly EECS 222A.

Restriction: Graduate students only.

EECS 223. Real-Time Computer Systems. 4 Units.
Time bases, clock synchronization, real-time communication protocols, specification of requirements, task scheduling. Validation of timelines, real-time configuration management.

Prerequisite: EECS 211 and EECS 213. EECS 211 with a grade of B- or better. EECS 213 with a grade of B- or better

Restriction: Graduate students only.

EECS 223P. Real-Time Computer Systems. 4 Units.
Time bases, clock synchronization, real-time communication protocols, specification of requirements, task scheduling. Validation of timelines, real-time configuration management.

Prerequisite: EECS 211P and EECS 213P. EECS 211P with a grade of B- or better. EECS 213P with a grade of B- or better

Restriction: Graduate students only. Master of Engineering students only.

EECS 224. High-Performance Computing. 4 Units.
Fundamentals of high-performance computing, covering both theory and practice. Topics include performance analysis and tuning, design of parallel and I/O efficient algorithms, basics of parallel machine architectures, and current/emerging programming models (shared memory, distributed memory, and accelerators).

Prerequisite: EECS 215 or COMPSCI 260. EECS 215 with a grade of B- or better. COMPSCI 260 with a grade of B- or better

Restriction: Graduate students only.

EECS 226. Embedded System Software. 4 Units.
Embedded system software concepts, requirements, examples, for engineering applications such as multi-media and automotive. Software generation methodology. Algorithmic specification, design constraints. Embedded operating systems. Static, dynamic, real-time scheduling. Input/output, interrupt handling. Code generation, compilation, instruction set simulation. Formerly EECS 222C.

Restriction: Graduate students only.

EECS 227. Cyber-Physical System Design. 4 Units.
Model-based design of cyber-physical systems including, e.g., plant, sensing, control, actuation, embedded hardware/software, communication, real-time analysis, various levels of simulation (MILS, SILS, HILS), tools and methodologies for automatic synthesis, and application from various interdisciplinary domains.

Restriction: Graduate students only.

EECS 230. Energy Efficiency. 4 Units.
Green energy sources for production, transmission, storage, and utilization of electricity, with a special focus on solar, wind, and nuclear energy production. Study of newly developed renewable sources of energy including capital cost, product cost, environmental issues, and technical feasibility.

EECS 230P. Introduction to Machine Learning. 4 Units.
Introduces fundamental concepts in programming and machine learning. The goal is to provide an accessible introduction to the field of machine learning and related techniques for students with a wide variety of engineering degrees.

Same as BME 230P, ENGRCEE 230P, ENGR 230P, ENGRMAE 230P.

Restriction: Master of Engineering students only.

EECS 231. Advanced System Security. 4 Units.
Advanced study about system security. Topics include software vulnerabilities (buffer overflow), vulnerability discovery (fuzzing), network security, side-channel analysis (power analysis and micro-architecture attacks), machine-learning security, IoT security, and privacy (differential privacy).

Restriction: Graduate students only.

EECS 232. Data Privacy. 4 Units.
Presents data privacy in the digital age from multiple perspectives, including theoretical frameworks for privacy; tracking practices and privacy-enhancing technologies in various application domains; and data protection laws and policy.

Prerequisite: Recommended: Students should have familiarity with networking (web/HTTP, DNS, mobile devices) (EECS 148 or equivalent), probability (EECS 55 or equivalent), and programming in python (EECS 12 or equivalent) at the undergraduate level.

Restriction: Graduate students only.

EECS 240. Random Processes. 4 Units.
Extensions of probability theory to random variables varying with time. General properties of stochastic processes. Convergence. Estimation, including nonlinear and linear minimum mean square error and maximum likelihood. Spectral density and linear filters. Poisson processes and discrete-time Markov chains.

Restriction: Graduate students only.

EECS 240P. Random Processes. 4 Units.
Extensions of probability theory to random variables varying with time. General properties of stochastic processes. Convergence. Estimation, including nonlinear and linear minimum mean square error and maximum likelihood. Spectral density and linear filters. Poisson processes and discrete-time Markov chains.

Prerequisite: Recommended: Knowledge of engineering probability (e.g. EECS 55).

Restriction: Master of Engineering students only. Graduate students only.

EECS 241A. Digital Communications I. 4 Units.
Concepts and applications of digital communication systems. Baseband digital transmission of binary, multiamplitude, and multidimensional signals. Introduction to and performance analysis of different modulation schemes.

EECS 241AP. Digital Communications I. 4 Units.
Concepts and applications of digital communication systems. Baseband digital transmission of binary, multiamplitude, and multidimensional signals. Introduction to and performance analysis of different modulation schemes.

Restriction: Master of Engineering students only. Graduate students only.

EECS 241B. Digital Communications II. 4 Units.
Concepts and applications of equalization, multi-carrier modulation, spread spectrum and CDMA. Digital communications through fading memory channels.

Prerequisite: EECS 241A. EECS 241A with a grade of B- or better

Restriction: Graduate students only.

EECS 241BP. Digital Communications II. 4 Units.
Concepts and applications of equalization, multi-carrier modulation, spread spectrum, and CDMA. Digital communications through fading memory channels.

Prerequisite: EECS 241AP. EECS 241AP with a grade of B- or better

Restriction: Graduate students only. Master of Engineering students only.

EECS 242. Information Theory. 4 Units.
Fundamental capabilities and limitations of information sources and information transmission systems. Analytical framework for modeling and evaluating communication systems: entropy, mutual information asymptotic equipartition property, entropy rates of a stochastic process, data compression, channel capacity, differential entropy, the Gaussian channel.

Prerequisite: EECS 240. EECS 240 with a grade of B- or better

EECS 244. Wireless Communications. 4 Units.
Introduction to wireless communications systems. Wireless channel modeling. Single carries, spread spectrum, and multi-carrier wireless modulation schemes. Diversity techniques. Multiple-access schemes. Transceiver design and system level tradeoffs. Brief overview of GSM, CDMA, (IS-95) and 2.5, 3G cellular schemes.

Prerequisite: EECS 241B. EECS 241B with a grade of B- or better

Restriction: Graduate students only.

EECS 244P. Wireless Communications. 4 Units.
Introduction to wireless communications systems. Wireless channel modeling. Single carries, spread spectrum, and multi-carrier wireless modulation schemes. Diversity techniques. Multiple-access schemes. Transceiver design and system level tradeoffs. Brief overview of GSM, CDMA, (IS-95) and 2.5, 3G cellular schemes.

Prerequisite: EECS 241BP. EECS 241BP with a grade of B- or better

Restriction: Graduate students only. Master of Engineering students only.

EECS 247. Information Storage. 4 Units.
Storage architecture, storage network and networking algorithms in data centers, principle of storage devices and non-volatile memory, data consistency, data availability and integrity, power management.

Restriction: Graduate students only.

EECS 248A. Computer and Communication Networks. 4 Units.
Network architecture of the Internet, telephone networks, cable networks, and cell phone networks. Network performance models. Network performance models. Advanced concepts and implementations of flow and congestion control, addressing, internetworking, forwarding, routing, multiple access, streaming, and quality-of-service.

Prerequisite: EECS 148 or COMPSCI 132

Same as COMPSCI 232, NET SYS 201.

Restriction: Graduate students only.

EECS 250. Digital Signal Processing I. 4 Units.
Fundamental principles of digital signal processing, sampling, decimation and interpolation, discrete Fourier transforms and FFT algorithms, transversal and recursive filters, discrete random processes, and finite-word effects in digital filters.

Restriction: Graduate students only.

EECS 250P. Digital Signal Processing I. 4 Units.
Fundamental principles of digital signal processing, sampling, decimation and interpolation, discrete Fourier transforms and FFT algorithms, transversal and recursive filters, discrete random processes, and finite-word effects in digital filters.

Prerequisite: Recommended: Knowledge of digital signal processing (e.g. EECS 152A).

Restriction: Master of Engineering students only. Graduate students only.

EECS 251A. Detection, Estimation, and Demodulation Theory. 4 Units.
Fundamentals of hypothesis testing and Bayes and Maximum Likelihood Estimation. ARMA and state variable models for random time series analysis. Wiener and Kalman filtering and prediction. Adaptive algorithms for identification and tracking of parameters of time-varying models.

Prerequisite: EECS 240. EECS 240 with a grade of B- or better

EECS 251B. Detection, Estimation, and Demodulation Theory. 4 Units.
Fundamentals of hypothesis testing and Bayes and Maximum Likelihood Estimation. ARMA and state variable models for random time series analysis. Wiener and Kalman filtering and prediction. Adaptive algorithms for identification and tracking of parameters of time-varying models.

Prerequisite: EECS 240. EECS 240 with a grade of B- or better

EECS 253. Machine Learning for Signal Processing. 4 Units.
Machine learning and computational neuroscience methods for signal processing. Theory and applications are described, as well as practical programming methods in Python using Keras and TensorFlow 2.

Prerequisite: Recommended: EECS 125 or equivalent undergraduate-level introduction to machine learning and EECS 152A or equivalent undergraduate course in digital signal processing. Knowledge of introductory linear algebra and differential equations, elementary probability theory, and elementary Python programming.

Restriction: Graduate students only.

EECS 254. Theory of Machine Learning. 4 Units.
The math background underlying machine learning algorithms and structures, including backpropagation, radial basis functions, deep belief nets, support vector machines, and dynamic programming. The relation of learning algorithms to estimation, recursive filtering, dimensionality reduction, and sequential optimization.

Prerequisite: Recommended: EECS 125 or equivalent undergraduate-level introduction to machine learning. Knowledge of introductory linear algebra and differential equations, elementary probability theory, and elementary Matlab programming.

Restriction: Graduate students only.

EECS 260A. Linear Systems I. 4 Units.
State-space representation of continuous-time and discrete-time linear systems. Controllability, observability, stability. Realization of rational transfer functions.

Restriction: Graduate students only.

EECS 261A. Linear Optimization Methods. 4 Units.
Formulation, solution, and analysis of linear programming and linear network flow problems. Simplex methods, dual ascent methods, interior point algorithms, and auction algorithms. Duality theory and sensitivity analysis. Shortest path, max-flow, assignment, and minimum cost flow problems.

Restriction: Graduate students only.

EECS 267A. Industrial and Power Electronics. 4 Units.
Power switching devices, pulse width modulation (PWM) methods, switching converter topologies, control, and magnetics. Materials fee.

Restriction: Graduate students only.

Concurrent with EECS 166A.

EECS 267B. Topics in Industrial and Power Electronics. 4 Units.
Practical design of switching converters, electromagnetic compatibility, thermal management, and/or control methods.

Prerequisite: EECS 267A. EECS 267A with a grade of B- or better

Restriction: Graduate students only.

EECS 270A. Advanced Analog Integrated Circuit Design I. 4 Units.
Basic transistor configurations; differential pairs; active load/current sources; supply/temperature-independent biasing; op-amp gain and output stages; amplifier frequency response and stability compensation; nonidealities in op-amps; noise and dynamic range in analog circuits.

Restriction: Graduate students only.

EECS 270AP. Advanced Analog Integrated Circuit Design I. 4 Units.
Basic transistor configurations; differential pairs; active load/current sources; supply/temperature-independent biasing; op-amp gain and output stages; amplifier frequency response and stability compensation; nonidealities in op-amps; noise and dynamic range in analog circuits.

Prerequisite: Recommended: Introductory knowledge of control systems (e.g. EECS 160A) and electronics (e.g. EECS 170C).

Restriction: Master of Engineering students only. Graduate students only.

EECS 270B. Advanced Analog Integrated Circuit Design II. 4 Units.
Advanced transistor modeling issues; discrete-time and continuous-time analog Integrated Circuit (IC) filters; phase-locked loops; design of ICs operating at radio frequencies; low-voltage/low-power design techniques; A/D and D/A converters; AGC circuits.

Prerequisite: EECS 270A. EECS 270A with a grade of B- or better

Restriction: Graduate students only.

EECS 270BP. Advanced Analog Integrated Circuit Design II. 4 Units.
Advanced transistor modeling issues; discrete-time and continuous-time analog Integrated Circuit (IC) filters; phase-locked loops; design of ICs operating at radio frequencies; low-voltage/low-power design techniques; A/D and D/A converters; AGC circuits.

Prerequisite: EECS 270AP. EECS 270AP with a grade of B- or better

Restriction: Graduate students only. Master of Engineering students only.

EECS 270C. Design of Integrated Circuits for Broadband Applications. 4 Units.
Topics include: broadband standards and protocols; high-frequency circuit design techniques; PLL theory and design; design of transceivers; electrical/optical interfaces.

Prerequisite: EECS 270A. EECS 270A with a grade of B- or better

Restriction: Graduate students only.

EECS 270D. Radio-Frequency Integrated Circuits and Systems. 4 Units.
Fundamental topics in radio-frequency (RF) integrated circuits and systems including basic concepts in RF circuits and systems, RF receiver and transmitter architectures, and RF core building blocks such as low-noise amplifiers (LNAs), RF mixers, and power amplifiers.

Prerequisite: EECS 270A. EECS 270A with a grade of B- or better

Restriction: Graduate students only.

EECS 270E. MM-Wave and Terahertz Circuits. 4 Units.
Discussion of the new methodologies, circuits, and systems developed at mm-wave and terahertz frequency ranges due to the growing interest in high speed communication and high frequency signal generation.

Restriction: Graduate students only.

EECS 272P. Radio-Frequency Integrated Circuit Design. 4 Units.
Topics include RF component modeling; matching network design; transmission line theory/modeling; Smith chart and S-parameters; noise modeling of active and passive components; high-frequency amplifier design; low-noise amplifier (LNA) design; mixer design; RF power amplifier.

Prerequisite: EECS 270AP. EECS 270AP with a grade of B or better

Restriction: Master of Engineering students only. Graduate students only.

EECS 277A. Advanced Semiconductor Devices I. 4 Units.
Advanced complementary metal-oxide-semiconductor field-effect transistors (CMOSFET), device scaling, device modeling and fabrication, equivalent circuits, and their applications for digital, analog, RF.

Restriction: Graduate students only.

EECS 277B. Advanced Semiconductor Devices II. 4 Units.
Metal-semiconductor field-effect transistors (MESFET), heterojunction bipolar transistors (HBT), microwave semiconductor devices, equivalent circuits, device modeling and fabrication, microwave amplifiers, transmitters, and receivers.

Restriction: Graduate students only.

EECS 277C. Nanotechnology. 4 Units.
Fabrication and characterization techniques of electrical circuit elements at the nanometer scale. Quantized conductance, semiconductor quantum dots, single electron transistors, molecular wires, carbon nanotubes, self-assembly of nano-circuit elements, quantum methods of information processing.

Restriction: Graduate students only.

EECS 278. Micro-System Design. 4 Units.
Covers the fundamentals of the many disciplines needed for design of Micro-Electro-Mechanical Systems (MEMS): microfabrication technology, structural mechanics on micro-scale, electrostatics, circuit interface, control, computer-aided design, and system integration.

Same as ENGRMAE 247.

Restriction: Graduate students only.

EECS 279. Micro-Sensors and Actuators. 4 Units.
Introduction to the technology of Micro-Electro-Mechanical Systems (MEMS). Fundamental principles and applications of important microsensors, actuation principles on microscale. Introduction to the elements of signal processing; processing of materials for micro sensor/actuator fabrication; smart sensors and microsensor/microactuator array devices.

Same as ENGRMAE 249.

Restriction: Graduate students only.

EECS 280A. Advanced Engineering Electromagnetics I. 4 Units.
Stationary electromagnetic fields, Maxwell's equations, circuits and transmission lines, plane waves, guided waves, and radiation.

Restriction: Graduate students only.

EECS 280B. Advanced Engineering Electromagnetics II. 4 Units.
Two- and three-dimensional boundary value problems, dielectric waveguides and other special waveguides, microwave networks and antenna arrays, electromagnetic properties of materials, and electromagnetic optics.

Prerequisite: EECS 280A. EECS 280A with a grade of B- or better

Restriction: Graduate students only.

EECS 280P. Advanced Engineering Electromagnetics I. 4 Units.
Stationary electromagnetic fields, Maxwell's equations, circuits and transmission lines, plane waves, guided waves, and radiation.

Prerequisite: Recommended: Knowledge of engineering electromagnetics (e.g. EECS 180A).

Restriction: Master of Engineering students only. Graduate students only.

EECS 282. Monolithic Microwave Integrated Circuit (MMIC) Analysis and Design II. 4 Units.
Design of microwave amplifiers using computer-aided design tools. Covers low-noise amplifiers, multiple stage amplifiers, broadband amplifiers, and power amplifiers. Hybrid circuit design techniques including filters and baluns. Theory and design rules for microwave oscillator design.

Restriction: Graduate students only.

EECS 284. Wireless Communication Links and Antenna Design. 4 Units.
Provides the fundamental understanding of the electromagnetic part of wireless communication links and their antennas, i.e., their key components. Contains hands-on component where students learn how to use the best CADs used in industry and academia.

Prerequisite: Recommended: EECS 180A

Concurrent with EECS 184.

EECS 284P. RF Antenna Design . 4 Units.
Advanced transmission line design, radiation of electromagnetic waves, dipole antennas, antenna arrays, advanced antenna designs, and practical design considerations in communications systems. Course is supplemented by RF design tools and modeling.

Prerequisite: EECS 280AP. EECS 280AP with a grade of B- or better

Restriction: Graduate students only. Master of Engineering students only.

EECS 285A. Optical Communications. 4 Units.
Introduction to fiber optic communication systems, optical and electro-optic materials, and high-speed optical modulation and switching devices.

Restriction: Graduate students only.

EECS 285B. Lasers and Photonics. 4 Units.
Covers the fundamentals of lasers and applications, including Gaussian beam propagation, interaction of optical radiation with matters, and concepts of optical gain and feedback. Applications are drawn from diverse fields of optical communication, signal processing, and material diagnosis.

Prerequisite: Undergraduate course work in electromagnetic theory and atomic physics.

EECS 285C. Nano Imaging. 4 Units.
Theory and practice of modern nanoscale imaging techniques and applications. Traces the development of microscopy from ancient times to modern day techniques used for visualizing the nano-world from atoms to molecules including hands-on experience in the laboratory.

Restriction: Graduate students only.

EECS 285P. Optical Communications. 4 Units.
Introduction to fiber optic communication systems, optical and electro-optic materials, and high-speed optical modulation and switching devices.

Prerequisite: Undergraduate-level Engineering Electromagnetics I (e.g. EECS E80A).

Restriction: Master of Engineering students only. Graduate students only.

EECS 286. Fabrication of Biomedical and Wearable Microdevices. 4 Units.
Covers preliminary details on prototyping and fabrication techniques for biomedical and wearable microdevices. Fabrication and behavior of modern biomed device materials such as hydrogel, PDMS, biopolymer, smart materials, and their uses are introduced.

Prerequisite: Required: Knowledge of undergraduate-level basic physics.

Restriction: Graduate students only.

EECS 287. Micro/Nano Biotechnology and Biosensing: Fundamentals, Designs, and Applications. 4 Units.
Provides insight into the current topics in Micro/Nanoscience, Micro/Nanotechnology fundamentals, and their modern-day applications in life sciences. Focus is on Micro/Nanodevices; Sensors' fundamentals; NanoBioSensors; Microfluidics; Micro/Nanofabrication, detection system-level characterization; performance determination; solid-state materials; and more.

Restriction: Graduate students only.

EECS 289. Bioinstrumentation. 4 Units.
Introduces instrumentation used in biomedical research, clinical medicine, and health monitoring. Interfacing of bioelectronics and biomedical sensing are taught with the most updated methods. The integration of bioinstrumentation with data science and cloud computing are introduced.

Restriction: Graduate students only.

EECS 292. Preparation for M.S. Comprehensive Examination. 1-8 Units.
Individual reading and preparation for the M.S. comprehensive examination.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

EECS 293. Preparation for Ph.D. Preliminary Examination. 1-8 Units.
Individual reading and preparation for the Ph.D. preliminary examination.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

EECS 294. Electrical Engineering and Computer Science Colloquium. 1 Unit.
Invited speakers discuss their latest research results in electrical engineering and computer science.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

EECS 295. Seminars in Engineering. 1-4 Units.
Scheduled each year by individual faculty in major field of interest.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EECS 295P. Special Topics in Electrical Engineering and Computer Science. 4 Units.
Studies in selected areas of Electrical Engineering. Topics addressed vary each quarter.

Repeatability: Unlimited as topics vary.

Restriction: Master of Engineering students only. Graduate students only.

EECS 296. Master of Science Thesis Research. 1-16 Units.
Individual research or investigation conducted in the pursuit of preparing and completing the thesis required for the M.S. degree in Engineering.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

EECS 297. Doctor of Philosophy Dissertation Research. 1-16 Units.
Individual research or investigation conducted in preparing and completing the dissertation required for the Ph.D. degree in Engineering.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

EECS 298. Topics in Electrical Engineering and Computer Science. 4 Units.
Study of Electrical and Computer Engineering concepts.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EECS 299. Individual Research. 1-16 Units.
Individual research or investigation under the direction of an individual faculty member.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.