ELECTRICAL AND COMPUTER ENGINEERING

Department of Electrical and Computer Engineering
College of Engineering

101 Introduction to Electrical and Computer Engineering
Fall, Spring. 1(0-3)

201 Circuits and Systems I
Fall, Spring. 3(3-0) P: (CSE 131 or concurrently) or (CSE 231 or concurrently) or (EGR 102 or concurrently) or (CSE 220 or concurrently) and ((MTH 234 or concurrently) or (MTH 254H or concurrently) or (LB 220 or concurrently)) SA: ECE 200

202 Circuits and Systems II
Fall, Spring. 3(3-0) P: ECE 201 and (MTH 235 or concurrently) or (MTH 255H or concurrently) or MTH 340 or MTH 347H SA: ECE 360

203 Electric Circuits and Systems Laboratory
Fall, Spring. 1(0-3) P: ECE 202 or concurrently
Electrical test equipment and measurement fundamentals. Circuit and filter design using integrated circuit amplifiers.

230 Digital Logic Fundamentals
Fall, Spring. 3(3-0) P: CSE 131 or CSE 231 or EGR 102 or CSE 220 SA: ECE 330

280 Electrical Engineering Analysis
Fall, Spring. 3(3-0) P: (MTH 234 or MTH 254H) and ECE 201 or concurrently
Application of linear algebra, complex numbers, vectors, probability, and random processes to elementary problems in electrical and computer engineering. Application to signals, systems, noise, electromagnetics, and reliability. Modeling using standard software packages.

302 Electronic Circuits
Fall, Spring. 3(3-0) P: ECE 202 and (ECE 280 or concurrently) R: Open to students in the Department of Electrical and Computer Engineering and open to students in the Department of Computer Science and Engineering. SA: EE 302
Volt-ampere characteristics of diodes and transistors. Modeling using SPICE software. Differential, multistage, and integrated circuit amplifiers. High frequency effects.

303 Electronics Laboratory
Fall, Spring. 1(0-3) P: ECE 203 and (ECE 302 or concurrently) and (ECE 280 or concurrently) R: Open to students in the Department of Electrical and Computer Engineering or in the Department of Electrical and Computer Engineering. SA: EE 303
Electronic test equipment and measurement fundamentals. Circuit design using diodes, transistors, integrated circuits, and sensors.

305 Electromagnetic Fields and Waves I
Fall, Spring, Summer. 4(4-0) P: ((MTH 235 or concurrently) or (MTH 255H or concurrently)) or (MTH 340 or MTH 347H) and (PHY 184 or PHY 184B or PHY 234B) or (ECE 280 and (ECE 202 or concurrently)) R: Open to students in the Department of Electrical and Computer Engineering and open to students in the Department of Computer Science and Engineering. SA: EE 305

313 Control Systems
Fall, Spring. 3(3-0) P: (ECE 202 or ECE 345) and ECE 280 R: Open to students in the Department of Electrical and Computer Engineering and open to students in the Department of Computer Science and Engineering. SA: EE 413, ECE 413
Analysis and design of control systems using transfer functions and state variable methods.

320 Energy Conversion and Power Electronics
Fall, Spring. 3(3-0) P: ECE 302 and ECE 303 and ECE 305 R: Open to students in the Department of Electrical and Computer Engineering and open to students in the Department of Computer Science and Engineering. SA: EE 320

331 Microprocessors and Digital Systems
Fall, Spring. 4(3-3) P: ((EGR 102 and (CSE 251 or concurrently)) or (CSE 232 or CSE 220)) and ECE 230 R: Open to students in the Department of Electrical and Computer Engineering and open to students in the Department of Computer Science and Engineering. SA: EE 331

345 Electronic Instrumentation and Systems
Fall, Spring. 3(3-3) P: (MTH 234 or concurrently) or (MTH 254H or concurrently) or (LB 220 or concurrently) and (PHY 184 or PHY 184B or PHY 234B) and completion of Tier I writing requirement) R: Open to juniors or seniors in the College of Engineering. SA: EE 345
Electrical and electronic components, circuits and instruments. Circuit laws and applications, frequency response, operational amplifiers, semi-conductor devices, digital logic, counting circuits.

366 Introduction to Signal Processing
Fall, Spring. 3(3-0) P: ECE 202 and ECE 280 R: Open to students in the Department of Electrical and Computer Engineering and open to students in the Department of Computer Science and Engineering. SA: ECE 360

390 Ethics, Professionalism and Contemporary Issues
Fall, Spring. 1(1-0) P: Completion of Tier I Writing Requirement R: Open to students in the Department of Electrical and Computer Engineering and open to students in the Department of Computer Science and Engineering.
Ethical theories and codes of ethics. Role of the engineer in society. Contemporary issues in electrical and computer engineering. Professionalism.

402 Applications of Analog Integrated Circuits
Spring. 4(3-3) P: ECE 302 and ECE 303 R: Open to students in the Department of Electrical and Computer Engineering and open to students in the Department of Computer Science and Engineering. SA: EE 484, EE 484
Circuit design using analog integrated circuits. SPICE. Linear and nonlinear systems. Operational amplifiers, comparators, timers, regulators, multiplexers and converters. Design project with hardware and software verification.

404 Radio Frequency Electronic Circuits
Fall. 4(3-3) P: ECE 302 and ECE 303 and ECE 305 R: Open to students in the Department of Electrical and Computer Engineering. Radio frequency active and passive circuit design. Impedance matching for specific bandwidths. Tuned amplifier, filter, mixer, and oscillator analysis. High frequency measurements and equipment.

405 Electromagnetic Fields and Waves II
Fall. 4(3-3) P: ECE 305 R: Open to juniors or seniors or graduate students in the Computer Engineering major or in the Electrical Engineering major. SA: ECE 435
Electrical and Computer Engineering—ECE

407 Electromagnetic Compatibility
Spring. 4(3-3) P: ECE 202 and ECE 305 and ECE 366 R: Open to juniors or seniors or graduate students in the Computer Engineering major or in the Electrical Engineering major.

410 VLSI Design
Spring. 4(3-3) P: ECE 302 and ECE 303 and ECE 230 R: Open to juniors or seniors or graduate students in the College of Engineering. SA: EE 410

411 Electronic Design Automation
Fall. 4(3-3) P: CSE 320 or ECE 331 R: Open to juniors or seniors or graduate students in the College of Engineering. SA: EE 411

412 Introduction to Mixed-Signal Circuit Design
Fall. 4(3-3) P: ECE 302 R: Open to students in the Department of Electrical and Computer Engineering. SA: ECE 418

415 Computer Aided Manufacturing
Fall. 3(2-3) P: ECE 313 or ME 451 R: Open to students in the Department of Electrical and Computer Engineering. SA: ECE 415
CAD/CAM fundamentals, programmable controllers, numerical control, NC part programming, sensors, data acquisition systems.

416 Digital Control
Spring. 3(2-3) P: ECE 303 and ECE 313 R: Open to juniors or seniors in the Computer Engineering major or in the Electrical Engineering major.

420 Machines and Power Laboratory
Fall. 1(3-0) P: (ECE 320 or concurrently) or (ECE 423 or concurrently) R: Open to juniors or seniors in the College of Engineering.
Experimental investigation of machines, power electronics and power systems. Experimental verification of material found in introductory courses on energy conversion with extension to power electronics and power systems.

423 Power System Analysis
Spring. 3(3-0) P: ECE 320 R: Open to students in the Department of Electrical and Computer Engineering and open to students in the Department of Computer Science and Engineering. SA: ECE 421

425 Solid State Power Conversion
Fall. 3(3-0) P: A student may earn a maximum of 3 credits in all enrollments for this course. P: ECE 320 and ECE 313 and (ECE 420 or concurrently) R: Open to undergraduate students in the Department of Electrical and Computer Engineering.

422 Introduction to Communication Networks
Fall. 3(3-0) P: ECE 280 or STT 351 R: Open to undergraduate students in the Department of Electrical and Computer Engineering.
Fundamental theories of communication networks with emphasis on statistical performance modeling of Medium Access Control, Data Link Control, Routing and Transport Layer protocols. Network design and analysis using basic probabilistic and statistical tools, including Little’s formula, Markov Chain, and introductory queuing theory. Discrete event simulation projects.

426 Biomedical Instrumentation
Fall of even years. 3(2-3) P: ECE 303 or ECE 345 R: Open to students in the College of Engineering.

446 Biomedical Signal Processing
Fall of odd years. 3(3-0) P: ECE 366 RB: Basic linear systems and probability theory. R: Open to students in the College of Engineering. Not open to students with credit in ECE 466.
Deterministic and random digital signal processing theory in the context of biomedical applications with computer projects on the analysis of real physiologic signals.

447 Introduction to Biomedical Imaging
Spring. 3(3-0) P: ECE 366 RB: ECE 305 R: Open to students in the College of Engineering.
Fundamental mathematics, physics, engineering principles, and applications of biomedical imaging techniques including ultrasound, x-ray imaging, computed tomography, nuclear medicine, including PET and SPECT, and magnetic resonance imaging.

448 Modeling and Analysis of Bioelectrical Systems
Spring of odd years. 3(3-0) P: ECE 366 and ECE 313 R: Open to students in the College of Engineering.
Basics of deterministic and stochastic linear systems. Principles of biophysics and biophotobiology. Theory and principles of system identification, methods to formulate dynamic mathematical and computer models of bioelectrical systems. Applications to neural systems and neuropsychiatrics.

457 Communication Systems
Spring. 3(3-0) P: ECE 302 and ECE 366 R: Open to students in the Department of Electrical and Computer Engineering and open to students in the Department of Computer Science and Engineering. SA: EE 457

458 Communication Systems Laboratory
Spring. 1(0-3) P: ECE 303 and (ECE 457 or concurrently) SA: EE 458
A projects laboratory in communication systems.

466 Digital Signal Processing and Filter Design
Fall. 3(3-0) P: ECE 366 R: Open to seniors or graduate students in the College of Engineering. SA: EE 466
Not open to students with credit in ECE 446.

474 Principles of Electronic Devices
Spring. 3(0-3) P: ECE 302 and ECE 305 SA: EE 474
Energy levels in atoms. Crystal properties, energy bands and charge carriers, semiconductors, transport properties of bulk materials. P-n junction diodes, bipolar transistors, field effect transistors.

476 Electro-Optics
Fall, Summer. 4(3-3) P: ECE 302 and ECE 303 and ECE 305 R: Open to juniors or seniors or graduate students in the Computer Engineering major or in the Electrical Engineering major. SA: EE 476
Operational theory, characteristics and applications of optical components, light emitting diodes, lasers, laser diodes, photodetectors, photovoltaics, fiber optics, optical modulators and non-linear optical devices.

477 Microelectronic Fabrication
Fall. 3(2-3) P: (ECE 474 or concurrently) and ECE 303 R: Open to juniors or seniors in the College of Engineering. SA: ECE 483
Microelectronic processing fundamentals and simulations. Comparison of current microfabrication technologies and their limitations.
Senior Design  
Fall, Spring. 4(3-3) P: (ECE 303 and ECE 313 and ECE 320 and ECE 331 and ECE 366 and (ECE 390 or concurrently)) or ((CSE 410 and (ECE 390 or concurrently)) and completion of Tier I writing requirement) R: Open to seniors in the Department of Electrical and Computer Engineering or in the College of Engineering. Electrical engineering and computer engineering senior design experience involving contemporary design tools and practices, engineering standards, cross-functional teaming, oral and written technical communication, and lifelong learning.

Independent Study  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course. R: Approval of department. SA: EE 490

Special Topics  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open to students in the College of Engineering. SA: EE 491

Undergraduate Research  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 4 credits in all enrollments for this course. R: Approval of department. SA: EE 499

Investigation of special topics in electrical engineering or computer engineering.

Independent Study  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course. R: Approval of department. SA: EE 801

Independent investigation of a topic in electrical engineering or computer engineering.

Selected Topics  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 21 credits in all enrollments for this course. R: Open to graduate students in the Department of Electrical and Computer Engineering.

Radio Frequency Integrated Circuits  
Fall, 3(3-0) RB: Electrical and Computer Engineering and Computer Science and Engineering. Transceiver architecture designs with emphasis on digital signal processing platforms, embedded software transceivers, receiver hardware and software considerations, signal structures and CMOS codes, software receivers.

814 Embedded Wireless RF Transceivers  
Fall of even years. 3(3-0) Transceiver architecture designs. Software components. Realtime computing and synchronization on digital signal processing platforms, embedded software transceivers, receiver hardware and software considerations, signal structures and CMOS codes, real-time acquisitions and tracking, synchronization, software receivers.

816 Cryptography and Network Security  
Spring of even years. 3(3-0) Major security techniques, including authenticity, confidentiality, message integrity, non-repudiation, and the mechanisms to achieve them. Network security and system security practices, including authentication practice, e-mail security, IP security, Web security, and firewalls.

Robotics  
Spring. 3(3-0) RB: ECE 313 or ME 451 R: Open only to graduate students in the College of Engineering. Robot modeling, kinematics, dynamics, trajectory planning, programming, sensors, controller design.

819 Smart Material Sensors and Actuators  
Fall of odd years. 3(3-0) RB: General background in mechanics, dynamics, and control systems at the undergraduate level is desirable although not required. Fundamentals of piezoelectric materials, magnetostrictive materials, shape memory alloys, electroactive polymers, and other emerging smart materials. Sensing and actuation mechanisms. Physics-based, control-oriented modeling of transducer dynamics. Modeling and control of hysteresis. Device and system applications in sensing, actuation, and energy harvesting.

Advanced Computer Architecture  
Fall, Spring. 3(3-0) Interdepartmental with Computer Science and Engineering. Administered by Computer Science and Engineering. RB: CSE 410 and CSE 420 R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 820 Instruction set architecture. Pipelining, vector processors, cache memory, high bandwidth memory design, virtual memory, input and output. Benchmarking techniques. New developments related to single CPU systems.

Advanced Power Electronics and Applications  
Fall. 3(3-0) RB: Power and computer engineering areas. Power semiconductor devices, circuits, control, and applications. Converter and inverter analysis and design, DSP (Digital Signal Processor) control and implementation. Automotive and utility applications.

Power System Stability and Control  
Fall of even years. 3(3-0) RB: ECE 826 SA: EE 823 Analysis and simulation of small and large disturbance stability of power systems. Generator, exciter, voltage regulator models. Design of excitation systems and power system stabilizers.

Alternating Current Electrical Machines and Drives  
Spring of even years. 3(3-0) RB: ECE 320 SA: EE 925 Analysis, modeling and design of synchronous, induction, and switched reluctance machines. Design drives for motion control and power system applications.

Analog Circuit Theory  

Analog Integrated Circuit Design  

Advanced Electromagnetic Fields and Waves I  

Advanced Electromagnetic Fields and Waves II  
Spring of even years. 3(3-0) RB: ECE 836 SA: EE 836 Theory of guided transmission system. Microstrip lines, metallic and dielectric waveguides, EM cavities. Excitation and discontinuities of waveguides. Surface wave and radiation modes. Integrated optics. Scattering of EM waves.

Computational Methods in Electromagnetics  

Evolutionary Computation  
Fall of even years. 3(3-0) Interdepartmental with Computer Science and Engineering. Administered by Computer Science and Engineering. RB: CSE 841 and CSE 440 R: Open to graduate students in the Department of Computer Science and Engineering and open to graduate students in the Department of Electrical and Computer Engineering or approval of department. Investigation of evolutionary computation from a historical, theoretical and application viewpoint. Readings from the present literature, experiments with provided software on the application of evolutionary computation principles.

Digital Image Processing  
Spring of even years. 3(3-0) RB: ECE 466 Fundamentals of vision and image formation, various image transforms, linear and nonlinear techniques for image enhancement, image restoration and deconvolution, Introduction to wavelet transforms and multi-resolution image processing techniques, morphological image processing, homomorphic filters, image reconstruction and analysis techniques, application to biomedical images.
850  Electrodynamics of Plasmas  
Spring of odd years. 3(3-0) Interdepartmental with Astronomy and Astrophysics and Physics. Administered by Electrical and Computer Engineering. RB: ECE 835 or PHY 488 SA: EE 850  

851  Linear Systems and Control  
Fall. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Electrical and Computer Engineering. RB: Undergraduate coverage of linear algebra, differential equations and control/systems  

853  Optimal Control  
Spring of odd years. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Electrical and Computer Engineering.  

854  Robust Control  
Spring of even years. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Mechanical Engineering. R: Open to graduate students in the College of Engineering.  

856  Wireless Communications and Networking  
Fall of even years. 3(3-0) RB: ECE 457  
Cellular system design, characterization of wireless channels, signaling and receiver design for mobile radio, multiple access techniques and mobility management.

863  Analysis of Stochastic Systems  
Fall. 3(3-0) RB: STT 441 SA: EE 863  
Advanced topics in random variable theory. Stochastic processes and stochastic calculus. Optimal systems for filtering and detection.

864  Detection and Estimation Theory  
Spring. 3(3-0) RB: ECE 863 SA: EE 864  
Analysis and implementation of statistical estimation and detection methods used in signal processing, communications, and control applications. Bayesian, Neyman-Pearson, and minimax detection schemes. Bayesian, mean-square-error, and maximum-likelihood estimation methods.

865  Analog and Digital Communications  
Fall of odd years. 3(3-0) RB: ECE 457 and ECE 863 SA: EE 865  
Optimum signal design in noisy channels, matched filters, quadrature sampling of band-pass signals in noise. Coherent and non-coherent binary modulation such as PSK, FSK, DPSK, M-array modulation, intersymbol interference, spread spectrum.

866  Time-Frequency and Wavelet Analysis  
Spring of even years. 3(3-0) RB: ECE 466  

867  Information Theory and Coding  
Fall of odd years. 3(3-0) Shannon information measures. Uniqueness theorem and chain rules of the entropy measures. Kullback-Leibler relative-entropy. The f-measure. Asymptotic Equipartition Property (AEP) for various sources. Channel capacity; discrete-memoryless and symmetric channels. The channel coding theorem. Rate-distortion theory. Applications of coding to modern communications and compression methods such as image

868  Signal Compression  
Fall of even years. 3(3-0) RB: Probability theory. Signal compression systems. Transform coding and signal compaction. The Karhunen-Loeve Transform (KLT). The Discrete Cosine Transform (DCT). Relationshp between DCT and KLT. Quantization of signals. Lloyd-Max and Entropy Coded scalar quantization. Entropy coding; Huffman and arithmetic entropy coding. Rate distortion theory. Communication channel models for compressed signals.

869  Micro-electro-mechanical Systems  
Fall. 3(3-0) RB: ECE 835 or PHY 488 SA: EE 860  
Development of a complete integrated microsystem from inception to final test. Design, fabrication and testing of integrated microsystems. Development of a complete multichip microsystem containing sensors, signal processing, and an output interface. Basic MOS device and circuit processes, wafer bonding and micromachining, low power portable devices and diamond MEMS chips.

870  Introduction to Micro-Electro-Mechanical Systems  
Fall. 3(3-0) RB: ECE 477 and ECE 474  

871  Fabrication  
Spring. 3(3-0) P: ECE 870 or ECE 477  
Development of a complete integrated microsystem from inception to final test. Design, fabrication and testing of integrated microsystems. Development of a complete multichip microsystem containing sensors, signal processing, and an output interface. Basic MOS device and circuit processes, wafer bonding and micromachining, low power portable devices and diamond MEMS chips.

874  Physical Electronics  
Fall. 3(3-0) SA: EE 874  

875  Electronic Devices  
Spring. 3(3-0) RB: ECE 874 SA: EE 875  
Operating properties of semiconductor devices including DC, AC, transient and noise models of FET, BJT, metal-semiconductor contact, heterostructure, microwave and photonic devices.

877  Cleanroom Procedures  
Fall. 3(2-3) R: Open to graduate students in the College of Engineering.  
Cleanroom procedures and safety. Instrumentation for microfabrication processes and device measurements. Fabrication and testing of devices.

885  Artificial Neural Networks  
Spring. 3(3-0) Interdepartmental with Computer Science and Engineering. Administered by Electrical and Computer Engineering. SA: EE 885  
921  Advanced Topics in Digital Circuits and Systems  
Fall, Spring. 3(3-0)  A student may earn a maximum of 6 credits in all enrollments for this course. Interdepartmental with Computer Science and Engineering. Administered by Electrical and Computer Engineering. SA: EE 921 
Topics vary each semester.

924  Power Electronic Systems for Renewable Energy, Transportation, and Utility Applications  
Spring of even years. 3(3-0)  P: ECE 821 

925  Advanced Topics in Power  
Spring. 3(3-0)  A student may earn a maximum of 9 credits in all enrollments for this course. SA: EE 925 
Topics vary each semester.

929  Advanced Topics in Electromagnetics  
Fall, Spring. 3 to 4 credits.  A student may earn a maximum of 10 credits in all enrollments for this course. SA: EE 929 
Topics vary each semester.

929B  Antenna Theory  
Fall of odd years, Spring of odd years. 4(4-0)  RB: ECE 835 SA: EE 929B 

929C  Geometrical Theory of Diffraction  
Fall of odd years, Spring of odd years. 3(3-0)  RB: ECE 835 SA: EE 929C 

929D  Fast Computational Methods in Electromagnetics and Acoustics  
Spring of odd years. 3(3-0)  P: ECE 835 R: Open to graduate students in the Department of Electrical and Computer Engineering and open to graduate students in the Department of Physics and Astronomy and open to graduate students in the Department of Mathematics. Computation-cost and complexity, structured matrices and polynomials. Fourier methods on uniform and non-uniform grids. Fast multipole methods for the Laplace equation. Fast multipole methods for the Helmholtz kernel. Plane wave time domain methods for the retarded potential, rank deficiency and SVD based methods.

931  Advanced Topics in Electronic Devices and Materials  
Fall, Spring. 1 to 4 credits.  A student may earn a maximum of 12 credits in all enrollments for this course. SA: EE 931 
Topics vary each semester.

931C  Properties of Semiconductors  
Fall of odd years, Spring of odd years. 3(3-0)  RB: ECE 874 SA: EE 931C 
Carrier scattering, single particle and collective transport, quantum effects, hot electron effects, electron-photon and electron-phonon interactions.

932  Advanced Topics in Analog Circuits  
Spring of odd years. 3(3-0) 
Variable topics in advanced circuit analysis.

960C  Networked and Embedded Control Systems  
Spring of odd years. 3(3-0)  P: ECE 851 

963  Advanced Topics in Systems  
Fall, Spring. 3(3-0)  A student may earn a maximum of 9 credits in all enrollments for this course. SA: EE 963 
Topics vary each semester.

966  Advanced Topics in Signal Processing  
Fall, Spring. 3(3-0)  A student may earn a maximum of 9 credits in all enrollments for this course. SA: EE 966 
Topics vary each semester.

966C  Advanced Topics in Statistical Signal Processing  
Fall of odd years, Spring of odd years. 3(3-0)  RB: ECE 466 and ECE 863 and ECE 864 SA: EE 966C 
Communication channels, noise models, hypothesis testing of signals by Bayesian minimax, and Neyman-Pearson criteria. Performance evaluation using ROC. Bayesian and maximum likelihood parameter estimation. Kalman-Bucy filtering.

989  Advanced Topics in Plasma  
Fall of odd years, Spring of odd years. 3(3-0)  A student may earn a maximum of 6 credits in all enrollments for this course. SA: EE 989 
Topics vary each semester.

999  Doctoral Dissertation Research  
Fall, Spring, Summer. 1 to 24 credits.  A student may earn a maximum of 36 credits in all enrollments for this course. SA: EE 999  
Doctoral dissertation research.