ELECTRICAL & COMPUTER ENGINEER (ECE)

ECE 111. INTRODUCTION TO ECE: TOOLS. (3 Credits)
Introduction to the electrical and computer engineering professional practice. Covers the foundations of engineering problem solving and other skills necessary for success. Students will be taught engineering practice through hands-on approaches. Recommended for electrical and computer engineering majors, and for those interested in engineering as a profession. Lec/lab. Has extra fees.
Recommended: Completion or concurrent enrollment in MTH 111

ECE 112. INTRODUCTION TO ECE: CONCEPTS. (3 Credits)
Basic electrical and computer engineering concepts, problem solving and hands-on laboratory project. Topics include electronic circuit and device models, digital logic, circuit analysis, and simulation tools. Lec/lab. Has extra fees.
Prerequisites: MTH 111 with C or better or MTH 112 with C or better or MTH 251 with C or better or MTH 251H with C or better or Math Placement Test with a score of 23

ECE 199. SPECIAL STUDIES. (0-16 Credits)
One-credit section. Graded P/N.
This course is repeatable for 16 credits.

ECE 271. DIGITAL LOGIC DESIGN. (3 Credits)
A first course in digital logic design. Data types and representations, Boolean algebra, state machines, simplification of switching expressions, and introductory computer arithmetic. Lec/rec.
Prerequisites: MTH 251 (may be taken concurrently) with C or better or MTH 251H (may be taken concurrently) with C or better or MTH 231 (may be taken concurrently) with C or better

ECE 272. DIGITAL LOGIC DESIGN LABORATORY. (1 Credit)
This laboratory course accompanies ECE 271, Digital Logic Design. This also illustrates topics covered in the lectures of ECE 271 using computer-aided design, verification tools, and prototyping hardware.
Recommended: Completion or concurrent enrollment in ECE 271

ECE 322. ELECTRONICS I. (3 Credits)
Fundamental device characteristics including diodes, MOSFETs and bipolar transistors; small- and large-signal characteristics and design of linear circuits.
Prerequisites: ENGR 203 with C or better
Equivalent to: ECE 322H

ECE 322H. ELECTRONICS I. (3 Credits)
Fundamental device characteristics including diodes, MOSFETs and bipolar transistors; small- and large-signal characteristics and design of linear circuits.
Attributes: HNRS – Honors Course Designator
Prerequisites: ENGR 203 with C- or better
Equivalent to: ECE 322

ECE 323. ELECTRONICS II. (3 Credits)
Transient operation of MOSFETs and bipolar transistors; multistage amplifiers; frequency response; feedback and stability.
Prerequisites: ECE 322 with C or better

ECE 331. ELECTROMECHANICAL ENERGY CONVERSION. (4 Credits)
Energy conversion principles for electric machines. Steady state characteristics of direct current, induction, and synchronous machines. Application of stepper and servo motors and synchronous generators.
Prerequisites: (ENGR 202 with C or better or ENGR 202H with C or better) and MTH 256 [C] and PH 213 [C]

ECE 332. LABORATORY ON ELECTROMECHANICAL ENERGY CONVERSION. (1 Credit)
DC, PMAC, and induction machine testing, operation, and control.
Prerequisites: ENGR 202 with C or better or ENGR 202H with C or better
Corequisites: ECE 331

ECE 341. JUNIOR DESIGN I. (3 Credits)
Introduction to system design and group projects. Design and fabrication of an electrical engineering project in a small group.
Prerequisites: CS 261 (may be taken concurrently) with C or better and ENGR 203 [C]

ECE 342. JUNIOR DESIGN II. (3 Credits)
Introduction to system design and group projects. Design and fabrication of an electrical engineering project in a small group.
Prerequisites: ECE 341 with C or better

ECE 351. SIGNALS AND SYSTEMS I. (3 Credits)
Analytical techniques for continuous-time and discrete-time signal, system, and circuit analysis. Lec.
Prerequisites: ENGR 203 with C or better and (MTH 256 [C] or MTH 256H [C])

ECE 352. SIGNALS AND SYSTEMS II. (3 Credits)
Analytical techniques for continuous-time and discrete-time signal, system, and circuit analysis.
Prerequisites: ECE 351 with C or better and (MTH 306 [C] or MTH 306H [C])

ECE 353. INTRODUCTION TO PROBABILITY AND RANDOM SIGNALS. (3 Credits)
Introductory discrete and continuous probability concepts, single and multiple random variable distributions, expectation, introductory stochastic processes, correlation and power spectral density properties of random signals, random signals through linear filters. Lec.
Prerequisites: ECE 351 with C or better and (MTH 254 [C] or MTH 254H [C])

ECE 372. INTRODUCTION TO COMPUTER NETWORKS. (4 Credits)
Computer network principles, fundamental networking concepts, packet-switching and circuit-switching, TCP/IP protocol layers, reliable data transfer, congestion control, flow control, packet forwarding and routing, MAC addressing, multiple access techniques. Lec. CROSSLISTED as CS 372.
Prerequisites: CS 261 with C or better and (ECE 271 [C] or CS 271 [C])
Equivalent to: CS 372
Recommended: C programming and Unix familiarity.

ECE 375. COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING. (4 Credits)
Introduction to computer organization, how major components in a computer system function together in executing a program, and assembly language programming. Lec/lab.
Prerequisites: ECE 271 with C or better
Recommended: CS 261 or C/C++ programming

ECE 390. ELECTRIC AND MAGNETIC FIELDS. (4 Credits)
Static and quasi-static electric and magnetic fields.
Prerequisites: (MTH 255 with C or better or MTH 255H with C or better) and ENGR 203 (may be taken concurrently) [C] and PH 213 [C]

ECE 391. TRANSMISSION LINES. (3 Credits)
Transient and steady-state analysis of transmission line circuits with application to engineering problems.
Prerequisites: ECE 322 (may be taken concurrently) with C or better and ENGR 203 [C] and (MTH 254 [C] or MTH 254H [C]) and (MTH 256 [C] or MTH 256H [C])
Equivalent to: ECE 391X

ECE 399. SPECIAL TOPICS. (1-16 Credits)
Course work to meet students' needs in advanced or specialized areas and to introduce new, important topics in electrical and computer engineering at the undergraduate (junior/senior) level.
Equivalent to: ECE 399H
This course is repeatable for 16 credits.

ECE 401. RESEARCH. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 403. THESIS. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 405. READING AND CONFERENCE. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 406. PROJECTS. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 410. INTERNSHIP. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 411. ENGINEERING MAGNETICS. (3 Credits)
Application of magnetic materials in the design of magnetic devices. Properties of magnetic materials; engineering design of actuators, sensors and data storage devices. Introduction to spintronics.
Prerequisites: ECE 390 with C or better

ECE 413. SENSORS. (3 Credits)
Overview of sensor technologies including materials, physics of operation, applications and system integration.
Prerequisites: ECE 323 with C or better and PH 213 [C] and (CH 201 [C] or CH 231 [C]) or (CH 121 [C] and CH 122 [C]) or (CH 231 [C] and CH 261 [C])

ECE 415. MATERIAL SCIENCE OF NANOTECHNOLOGY. (3 Credits)
Introductory physical chemistry of solid surfaces, thermodynamics, and kinetics applied to synthesis of nanomaterials such as nanoparticles, nanowires, thin films, carbon nanotubes, fullerenes, graphene, etc. Characterization of nanomaterials, applications of nanomaterials, nano-synthesis techniques, integration of nanotechnology, and emerging nanotechnology topics.
Prerequisites: ECE 416 with C or better or ENGR 321 with C or better or ENGR 321H with C or better

ECE 416. ELECTRONIC MATERIALS AND DEVICES. (4 Credits)
Semiconductor fundamentals and physical principles of pn junctions and Schottky barrier diodes.
Prerequisites: ENGR 201 with C or better and PH 213 [C] and (CH 201 [C] or CH 231 [C]) or (CH 121 [C] and CH 122 [C]) or (CH 231 [C] and CH 261 [C])
Equivalent to: ECE 317

ECE 417. BASIC SEMICONDUCTOR DEVICES. (4 Credits)
Theory and physical principles of bipolar junction and field-effect transistors. Lec/rec.
Prerequisites: ECE 416 with C or better

ECE 418. SEMICONDUCTOR PROCESSING. (4 Credits)
Theory and practice of basic semiconductor processing techniques. Introduction to process simulation. Lec/lab/rec.
Prerequisites: ECE 416 with C or better

ECE 422. CMOS INTEGRATED CIRCUITS I. (4 Credits)
Analysis and design of analog integrated circuits in CMOS technology; current mirrors, gain stages, single-ended operational amplifier, frequency response, and compensation.
Prerequisites: ECE 322 with C or better and ECE 323 (may be taken concurrently) [C]

ECE 423. CMOS INTEGRATED CIRCUITS II. (4 Credits)
Analysis and design of analog integrated circuits in CMOS technology; cascaded current mirrors, cascaded gain stages, single-ended and fully differential operational amplifier, common-mode feedback, noise, and distortion. Lec/lab.
Prerequisites: ECE 422 with C or better

ECE 431. POWER ELECTRONICS. (4 Credits)
Fundamentals and applications of devices, circuits and controllers used in systems for electronic power processing. Lec/lab.
Prerequisites: ECE 322 with C or better and ECE 323 (may be taken concurrently) [C] and ECE 351 [C]

ECE 432. DYNAMICS OF ELECTROMECHANICAL ENERGY CONVERSION. (4 Credits)
Generalized machine theory. Techniques for dynamic analysis of electromechanical machines including arbitrary reference frame theory. Lec/lab.
Prerequisites: ECE 331 with C or better and ENGR 203 [C]
Corequisites: ECE 431

ECE 433. POWER SYSTEM ANALYSIS. (4 Credits)
Fundamentals and control of real and reactive power, steady-state load flow studies, unbalance, stability and transient system analysis.
Prerequisites: ECE 323 with C or better and ECE 352 [C] and (ENGR 202 [C] or ENGR 202H [C]) and MTH 254 [C] and MTH 306 [C]
Recommended: Three-phase power

ECE 437. SMART GRID. (3 Credits)
Fundamentals of smart power grids. Technology advances in transmission and distribution systems, policy drivers, assets and demand management, and smart grid security.
Prerequisites: ECE 433 with C or better
Recommended: Background in power systems analysis equivalent to ECE 433

ECE 438. ELECTRIC AND HYBRID ELECTRIC VEHICLES. (4 Credits)
Transportation electrification history, hybrid electric vehicle architecture, powertrain components and their modeling and control, vehicle system dynamics and controls.
Prerequisites: ECE 331 with C or better and ECE 431 [C]

ECE 441. ^ENGINEERING DESIGN PROJECT. (3 Credits)
First term of an extended, 3-term team design project to expose students to problem situations and issues in engineering design similar to those encountered in industry. (Writing Intensive Courses)
Attributes: CWIC – Core, Skills, WIC
Prerequisites: ECE 322 with C or better and ECE 351 [C] and ECE 342 [C]

ECE 442. ^ENGINEERING DESIGN PROJECT. (3 Credits)
Second term of an extended, 3-term team design project to expose students to problem situations and issues in engineering design similar to those encountered in industry. (Writing Intensive Courses)
Attributes: CWIC – Core, Skills, WIC
Prerequisites: ECE 441 with C or better

ECE 443. ^ENGINEERING DESIGN PROJECT. (2 Credits)
An extended team design project to expose students to problem situations and issues in engineering design similar to those encountered in industry. (Writing Intensive Courses)
Attributes: CWIC – Core, Skills, WIC
Prerequisites: ECE 442 with C or better

ECE 451. SYSTEMS DYNAMICS AND CONTROL. (4 Credits)
Modeling and analysis of linear continuous systems in time and frequency domains. Fundamentals of single-input-single-output control system design. CROSSLISTED as ME 430.
Prerequisites: (ME 317 with C or better or (ECE 351 with C or better and ECE 352 [C] and (ENGR 212 [C] or ENGR 212H [C])))
Equivalent to: ECE 452, ME 430

ECE 461. INTRODUCTION TO ANALOG AND DIGITAL COMMUNICATIONS. (4 Credits)
Fundamental concepts of analog and digital telecommunication systems: modeling, analysis, and design of analog amplitude and angle modulation systems; probabilistic performance assessment of modulated signals over noisy channels; introduction to baseband digital modulation techniques such as binary pulse amplitude modulation and pulse position modulation and their demodulation in the presence of random noise. Lec.
Prerequisites: ECE 351 with C or better and ECE 352 [C] and ECE 353 [C]

ECE 462. DIGITAL COMMUNICATIONS AND CHANNEL CODING. (4 Credits)
Modeling, analysis, design of baseband and passband digital communications systems: geometric representation of signals; correlator receivers for M-ary digital communications systems; decision theory and its application to digital communication systems in additive white Gaussian noise environment; generation, transmission, and reception of passband digital modulated signals (BPSK, QPSK, FSK PAM); basics of information theory and channel encoding. Lec.
Prerequisites: ECE 461 with C or better and ECE 351 [C] and ECE 352 [C] and ECE 353 [C]

ECE 463. WIRELESS COMMUNICATIONS NETWORK. (4 Credits)
Wireless networks: personal area (IEEE 802.15.4a), local area (IEEE 802.11), metropolitan area (IEEE 802.16), and mobile cellular networks (e.g., CDMA); physical-layer techniques for data modulation and multiple access; RF system engineering aspects of mobile cellular networks (e.g., system capability for voice and packet data traffics, RF coverage for a certain propagation environment.) Lec.
Prerequisites: ECE 351 with C or better and ECE 352 [C]
Recommended: Probability background and ECE 461

ECE 464. DIGITAL SIGNAL PROCESSING. (4 Credits)
Analysis and design of discrete-time linear-time invariant systems for processing discrete-time signals: DT-LTI system properties, DT signal analysis using Discrete-Time Fourier Transform, Discrete Fourier Transform and z-Transform, frequency response and transfer function. Signal sampling and reconstruction, digital processing of continuous-time signals, FIR and IIR digital filter design, and filter structures.
Prerequisites: ECE 351 with C or better and ECE 352 [C]

ECE 468. DIGITAL IMAGE PROCESSING. (3 Credits)
Introduction to digital image processing including fundamental concepts of visual perception, image sampling and quantization, image enhancement in spatial and frequency domains (through 2D Fourier transform), image restoration, and color image processing. Implementation of algorithms using Matlab Image Processing Toolbox.
Prerequisites: ECE 351 with C or better and ECE 352 [C]

ECE 471. ENERGY-EFFICIENT VLSI DESIGN. (4 Credits)
Combinational and sequential logic design using CMOS transistors; analysis of power consumption and logic delay of digital logic; clock design including skew, jitter, and dynamic clock energy consumption; supply voltage and power supply noise sources; dynamic voltage frequency scaling (DVFS); sub-threshold logic design and effect on energy/robustness; custom digital integrated circuit design including transistor layouts and CAD entry; CMOS scaling and the effect on process variability and power consumption. Lec/lab.
Prerequisites: ECE 271 with C or better and ECE 322 [C] and ECE 323 (may be taken concurrently) [C]

ECE 472. COMPUTER ARCHITECTURE. (4 Credits)
Computer architecture using processors, memories, and I/O devices as building blocks. Issues involved in the design of instruction set architecture, processor, pipelining, and memory organization. Design philosophies and trade-offs involved in Reduced Instruction Set Computer (RISC) architectures. Lec/lab. CROSSLISTED as CS 472/ CS 572.
Prerequisites: ECE 375 with C or better
Equivalent to: CS 472

ECE 473. MICROCONTROLLER SYSTEM DESIGN. (4 Credits)
Implementation of embedded computer systems focusing on the development of hardware and software for an embedded microcontroller system. Topics include internal microcontroller architecture, interfacing peripheral devices, mixed analog and digital systems, and hardware and software implementation of several systems using a microcontroller and peripherals. Lec/lab.
Prerequisites: ECE 322 with C or better and ECE 375 [C] and CS 261 [C]

ECE 474. VLSI SYSTEM DESIGN. (4 Credits)
Introduction to custom and semi-custom digital integrated circuit design as used in VLSI systems. The use of CAD/CAE tools, design management, and design methodology are introduced.
Prerequisites: ECE 322 with C or better and ECE 375 [C]

ECE 476. ADVANCED COMPUTER NETWORKING. (4 Credits)
Advanced networking concepts: source/channel coding, queuing theory, router design, network architectures (Intserv, DiffServ, MPLS), multimedia protocols (TFRC, RTP), overlay networks, and wireless standards (Bluetooth 802.11b, 3/4G). CROSSLISTED as CS 476/CS 576.
Prerequisites: (CS 372 with C or better or ECE 372 with C or better) and (ECE 353 [C] or ST 314 [C] or ST 314H [C])
Equivalent to: EECS 476

ECE 477. MULTIMEDIA SYSTEMS. (4 Credits)
Design of multimedia systems used in information technology covering the hardware, software, applications, and networks. Components covered include multimedia representation, coding and compression techniques, wireless networks, networking for multimedia, and embedded system for multimedia. Lec.
Recommended: ECE 375

ECE 478. NETWORK SECURITY. (4 Credits)
Basic concepts and techniques in network security, risks and vulnerabilities, applied cryptography and various network security protocols. Coverage of high-level concepts such as authentication, confidentiality, integrity, and availability applied to networking systems. Fundamental techniques including authentication protocols, group key establishment and management, trusted intermediaries, public key infrastructures, SSL/TLS, IPSec, firewalls and intrusion detection. CROSSLISTED as CS 478.
Prerequisites: CS 372 with C or better or ECE 372 with C or better
Equivalent to: CS 478
Recommended: CS 370

ECE 482. OPTICAL ELECTRONIC SYSTEMS. (4 Credits)
Photodetectors, laser theory, and laser systems. Lec/lab. CROSSLISTED as PH 482/PH 582.
Equivalent to: PH 482
Recommended: ECE 391 or (PH 481 or PH 581)

ECE 483. GUIDED WAVE OPTICS. (4 Credits)
Optical fibers, fiber mode structure and polarization effects, fiber interferometry, fiber sensors, optical communication systems. Lec/lab. CROSSLISTED as PH 483/PH 583.
Prerequisites: ECE 391 (may be taken concurrently) with C or better or PH 481 (may be taken concurrently) with C or better
Equivalent to: PH 483

ECE 484. ANTENNAS AND PROPAGATION. (4 Credits)
Introduction to antennas and radiowave propagation. Offered alternate years.
Prerequisites: (ECE 390 with C or better and ECE 391 [C])

ECE 485. MICROWAVE DESIGN TECHNIQUES. (4 Credits)
Introduction to basic design techniques required for the design of high-frequency circuits and systems. Lec/Lab.
Prerequisites: ECE 390 with C or better and ECE 391 [C]

ECE 499. SPECIAL TOPICS. (0-16 Credits)
Course work to meet students' needs in advanced or specialized areas and to introduce new important topics in electrical and computer engineering at the undergraduate level.
This course is repeatable for 16 credits.

ECE 501. RESEARCH. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 503. ECE MS THESIS. (1-16 Credits)
This course is repeatable for 999 credits.

ECE 505. READING AND CONFERENCE. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 506. PROJECTS. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 507. SEMINAR. (1-16 Credits)
Graded P/N.
This course is repeatable for 16 credits.

ECE 516. ELECTRONIC MATERIALS AND DEVICES. (4 Credits)
Semiconductor fundamentals and physical principles of pn junctions and Schottky barrier diodes.
Equivalent to: ECE 317
Recommended: ENGR 201

ECE 517. BASIC SEMICONDUCTOR DEVICES. (4 Credits)
Theory and physical principles of bipolar junction and field-effect transistors. Lec/rec.
Recommended: ECE 416

ECE 518. SEMICONDUCTOR PROCESSING. (4 Credits)
Theory and practice of basic semiconductor processing techniques. Introduction to process simulation. Lec/lab/rec.
Recommended: ECE 416

ECE 520. ANALOG CMOS INTEGRATED CIRCUITS. (4 Credits)
Principles and techniques of design of electronic circuits with focus on a design methodology for analog integrated circuits. Practical aspects of using CAD tools in analyzing and laying out circuits will be discussed.

ECE 521. ANALOG CIRCUIT SIMULATION. (4 Credits)
Formulation/solution of circuit equations; sparse matrix techniques; DC, transient, sensitivity, noise and Fourier analyses; RF circuit simulation.
Recommended: ECE 423 or ECE 520

ECE 522. CMOS INTEGRATED CIRCUITS I. (4 Credits)
Analysis and design of analog integrated circuits in CMOS technology; current mirrors, gain stages, single-ended operational amplifier, frequency response, and compensation.
Recommended: ECE 322 and completion or concurrent enrollment in ECE 323

ECE 523. CMOS INTEGRATED CIRCUITS II. (4 Credits)
Analysis and design of analog integrated circuits in CMOS technology; cascaded current mirrors, cascaded gain stages, single-ended and fully differential operational amplifier, common-mode feedback, noise, and distortion. Lec/lab.
Recommended: ECE 422 or ECE 522

ECE 530. CONTEMPORARY ENERGY APPLICATIONS. (4 Credits)
Contemporary energy issues and applications; fundamental physics of renewable energy sources (e.g. wind, wave, and solar), devices used to harvest energy from these sources, state-of-the-art renewable energy technology, power transmission, transformers, and energy storage.
Recommended: Matlab, basic circuit analysis with RLC components and diode

ECE 531. POWER ELECTRONICS. (4 Credits)
Fundamentals and applications of devices, circuits and controllers used in systems for electronic power processing. Lec/lab.
Recommended: ECE 322 and ECE 351 and completion or concurrent enrollment in ECE 323

ECE 532. DYNAMICS OF ELECTROMECHANICAL ENERGY CONVERSION. (4 Credits)
Generalized machine theory. Techniques for dynamic analysis of electromechanical machines including arbitrary reference frame theory. Lec/lab.
Corequisites: ECE 531
Recommended: ECE 331

ECE 533. POWER SYSTEM ANALYSIS. (4 Credits)
Fundamentals and control of real and reactive power, steady-state load flow studies, unbalance, stability and transient system analysis.
Recommended: ECE 323 and ECE 352 and three-phase power

ECE 534. ADVANCED ELECTRICAL MACHINES. (3 Credits)
Development of models for the dynamic performance of all classes of electrical machines; synchronous, induction, permanent magnet and reluctance motors. Dynamic motor simulations.
Equivalent to: ECE 538
Recommended: ECE 530

ECE 535. ADJUSTABLE SPEED DRIVES AND MOTION CONTROL. (3 Credits)
Adjustable speed drives, associated power electronic converters, simulation and control. Lec.
Equivalent to: ECE 647
Recommended: ECE 530

ECE 536. POWER SYSTEM PROTECTION. (3 Credits)
Fundamentals of protective relaying. Relay input sources. Generation, transmission, and distribution systems protection. Stability and load shedding.
Recommended: ECE 433 or ECE 533

ECE 537. SMART GRID. (3 Credits)
Fundamentals of smart power grids. Technology advances in transmission and distribution systems, policy drivers, assets and demand management, and smart grid security.
Recommended: Background in power systems analysis equivalent to ECE 433

ECE 538. ELECTRIC AND HYBRID ELECTRIC VEHICLES. (4 Credits)
Transportation electrification history, hybrid electric vehicle architecture, powertrain components and their modeling and control, vehicle system dynamics and controls.
Equivalent to: ECE 534
Recommended: ECE 331 and ECE 431

ECE 550. LINEAR SYSTEMS. (4 Credits)
Linear dynamic systems theory and modeling.
Recommended: ECE 351 and ECE 352

ECE 560. STOCHASTIC SIGNALS AND SYSTEMS. (4 Credits)
Stochastic processes, correlation functions, spectral analysis applicable to communication and control systems.
Recommended: ECE 461 or ECE 561

ECE 561. INTRODUCTION TO ANALOG AND DIGITAL COMMUNICATIONS. (4 Credits)
Fundamental concepts of analog and digital telecommunication systems: modeling, analysis, and design of analog amplitude and angle modulation systems; probabilistic performance assessment of modulated signals over noisy channels; introduction to baseband digital modulation techniques such as binary pulse amplitude modulation and pulse position modulation and their demodulation in the presence of random noise. Lec.
Recommended: ECE 351 and ECE 352 and ECE 353

ECE 562. DIGITAL COMMUNICATIONS AND CHANNEL CODING. (4 Credits)
Modeling, analysis, design of baseband and passband digital communications systems: geometric representation of signals; correlator receivers for M-ary digital communications systems; decision theory and its application to digital communication systems in additive white Gaussian noise environment; generation, transmission, and reception of passband digital modulated signals (BPSK, QPSK, FSK PAM); basics of information theory and channel encoding. Lec.
Recommended: ECE 461 and ECE 351 and ECE 352 and ECE 353

ECE 563. WIRELESS COMMUNICATIONS NETWORK. (4 Credits)
Wireless networks: personal area (IEEE 802.15.4a), local area (IEEE 802.11), metropolitan area (IEEE 802.16), and mobile cellular networks (e.g., CDMA); physical-layer techniques for data modulation and multiple access; RF system engineering aspects of mobile cellular networks (e.g., system capability for voice and packet data traffics, RF coverage for a certain propagation environment.) Lec.
Recommended: Probability background and ECE 461

ECE 564. DIGITAL SIGNAL PROCESSING. (4 Credits)
Analysis and design of discrete-time linear-time invariant systems for processing discrete-time signals: DT-LTI system properties, DT signal analysis using Discrete-Time Fourier Transform, Discrete Fourier Transform and z-Transform, frequency response and transfer function. Signal sampling and reconstruction, digital processing of continuous-time signals, FIR and IIR digital filter design, and filter structures.
Recommended: ECE 351 and ECE 352

ECE 565. ESTIMATION, FILTERING, AND DETECTION. (4 Credits)
Principles of estimation, linear filtering, and detection.
Recommended: ECE 353

ECE 566. INFORMATION THEORY. (4 Credits)
Introduction to information theory: entropy, differential entropy, entropy rates, mutual information, data compression, channel capacity, source coding, channel coding, network information theory.
Recommended: ECE 353 and strong mathematical background

ECE 569. CONVEX OPTIMIZATION. (4 Credits)
Introduces the fundamental concepts, theories of convex and nonconvex optimization, and the algorithmic solutions as well as applications to many research disciplines including signal processing, networking, communications, and machine learning. Emphasis will be on (i) convex analysis and optimality conditions, (ii) first-order large-scale algorithms (gradient, proximal gradient, ADMM, Frank-Wolfe, stochastic gradient, block coordinate descent), and (iii) convergence analysis.
Recommended: Linear algebra and ECE 599 Matrix Analysis for Signal Processing

ECE 570. HIGH PERFORMANCE COMPUTER ARCHITECTURE. (4 Credits)
Advanced concepts in computer architecture. Performance improvement employing advanced pipelining and multiple instruction scheduling techniques. Issues in memory hierarchy and management. CROSSLISTED as CS 570.
Equivalent to: CS 570
Recommended: ECE 472 or ECE 572

ECE 571. ENERGY-EFFICIENT VLSI DESIGN. (4 Credits)
Combinational and sequential logic design using CMOS transistors; analysis of power consumption and logic delay of digital logic; clock design including skew, jitter, and dynamic clock energy consumption; supply voltage and power supply noise sources; dynamic voltage frequency and scaling (DVFS); sub-threshold logic design and effect on energy/robustness; custom digital integrated circuit design including transistor layouts and CAD entry; CMOS scaling and the effect on process variability and power consumption. Lec/lab.
Equivalent to: ECE 573
Recommended: ECE 271 and ECE 322 and completion or concurrent enrollment in ECE 323 (all with a minimum grade of C)

ECE 572. COMPUTER ARCHITECTURE. (4 Credits)
Computer architecture using processors, memories, and I/O devices as building blocks. Issues involved in the design of instruction set architecture, processor, pipelining, and memory organization. Design philosophies and trade-offs involved in Reduced Instruction Set Computer (RISC) architectures. Lec/lab. CROSSLISTED as CS 472/CS 572.
Equivalent to: CS 572
Recommended: ECE 375

ECE 573. MICROCONTROLLER SYSTEM DESIGN. (4 Credits)
Implementation of embedded computer systems focusing on the development of hardware and software for an embedded microcontroller system. Topics include internal microcontroller architecture, interfacing peripheral devices, mixed analog and digital systems, and hardware and software implementation of several systems using a microcontroller and peripherals. Lec/lab.
Equivalent to: ECE 571
Recommended: ECE 322 and ECE 375 and CS 261

ECE 574. VLSI SYSTEM DESIGN. (4 Credits)
Introduction to custom and semi-custom digital integrated circuit design as used in VLSI systems. The use of CAD/CAE tools, design management, and design methodology are introduced.
Recommended: ECE 322 or ECE 375

ECE 575. DATA SECURITY AND CRYPTOGRAPHY. (3 Credits)
Secret-key and public-key cryptography, authentication and digital signatures, protocols, implementation issues, privacy enhanced mail, data and communication security standards.

ECE 576. ADVANCED COMPUTER NETWORKING. (4 Credits)
Advanced networking concepts: source/channel coding, queuing theory, router design, network architectures (Intserv, DiffServ, MPLS), multimedia protocols (TFRC, RTP), overlay networks, and wireless standards (Bluetooth 802.11b, 3/4G). CROSSLISTED as CS 476/CS 576.
Equivalent to: CS 576, ECE 566
Recommended: (CS 372 or ECE 372) and (ECE 353 or ST 314 or ST 314H)

ECE 577. MULTIMEDIA SYSTEMS. (4 Credits)
Design of multimedia systems for information technology covering the hardware, software, applications, and networks. Components covered include multimedia representation, coding and compression techniques, wireless networks, networking for multimedia, and embedded system for multimedia. Lec.
Recommended: ECE 375

ECE 578. CYBER-SECURITY. (4 Credits)
A broad overview of the field of computer and network security. Essential cryptographic mechanisms such as symmetric and public-key cryptography (e.g., encryption, signatures), network security and authentication protocols (e.g., Kerberos, TLS, IPSec), system security (e.g., access control, firewalls), advanced topics (e.g., searchable encryption, cloud security, secure computation). CROSSLISTED as CS 578.
Equivalent to: CS 578

ECE 580. NETWORK THEORY. (4 Credits)
Linear graphs, multiport networks, and other topics in advanced network theory.

ECE 582. OPTICAL ELECTRONIC SYSTEMS. (4 Credits)
Photodetectors, laser theory, and laser systems. Lec/lab. CROSSLISTED as PH 482/PH 582.
Equivalent to: PH 582
Recommended: PH 481 or PH 581

ECE 583. GUIDED WAVE OPTICS. (4 Credits)
Optical fibers, fiber mode structure and polarization effects, fiber interferometry, fiber sensors, optical communication systems. Lec/lab. CROSSLISTED as PH 483/PH 583.
Equivalent to: PH 583
Recommended: Completion or concurrent enrollment in (ECE 391 or PH 481 or PH 581)

ECE 584. ANTENNAS AND PROPAGATION. (4 Credits)
Introduction to antennas and radiowave propagation. Offered alternate years.

ECE 585. MICROWAVE DESIGN TECHNIQUES. (4 Credits)
Introduction to basic design techniques required for the design of high-frequency circuits and systems. Lec/Lab.

ECE 590. ANALYTICAL TECHNIQUES IN ELECTROMAGNETIC FIELDS. (4 Credits)
Basic analytical techniques required to solve meaningful field problems in engineering.

ECE 591. ADVANCED ELECTROMAGNETICS. (3 Credits)
Advanced techniques for analyzing problems in electromagnetics, primarily numerical. Offered alternate years.
Recommended: ECE 590

ECE 593. RF MICROWAVE CIRCUIT DESIGN. (3 Credits)
Active/passive RF and microwave circuit design with emphasis to wireless systems.
Recommended: ECE 390 and ECE 391

ECE 599. SPECIAL TOPICS. (0-16 Credits)
Course work to meet students' needs in advanced or specialized areas and to introduce new important topics in electrical and computer engineering at the graduate level.
This course is repeatable for 99 credits.

ECE 601. RESEARCH. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 603. ECE PhD THESIS. (1-16 Credits)
This course is repeatable for 999 credits.

ECE 605. READING AND CONFERENCE. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 606. PROJECTS. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 607. SEMINAR. (1-16 Credits)
This course is repeatable for 16 credits.

ECE 611. ELECTRONIC MATERIALS PROCESSING. (3 Credits)
Technology, theory, and analysis of processing methods used in integration circuit fabrication. Offered alternate years. CROSSLISTED as CHE 611.
Equivalent to: CHE 611, ECE 511

ECE 612. PROCESS INTEGRATION. (3 Credits)
Process integration, simulation, and statistical quality control issues related to integrated circuit fabrication. Offered alternate years. CROSSLISTED as CHE 612.
Equivalent to: CHE 612, ECE 512
Recommended: ECE 611 or CHE 611

ECE 613. ELECTRONIC MATERIALS AND CHARACTERIZATION. (3 Credits)
Physics and chemistry of electronic materials and methods of materials characterization. Offered alternate years. CROSSLISTED as CHE 613.
Equivalent to: CHE 613, ECE 513

ECE 614. SEMICONDUCTORS. (3 Credits)
Essential aspects of semiconductor physics relevant for an advanced understanding of semiconductor materials and devices. Offered alternate years.
Equivalent to: ECE 514
Recommended: Exposure to quantum mechanics and solid state physics.

ECE 615. SEMICONDUCTOR DEVICES I. (3 Credits)
Advanced treatment of two-terminal semiconductor electronic devices. Offered alternate years.
Equivalent to: ECE 515
Recommended: ECE 614

ECE 616. SEMICONDUCTOR DEVICES II. (3 Credits)
Advanced treatment of three-terminal semiconductor electronic devices. Offered alternate years.
Equivalent to: ECE 516
Recommended: ECE 615

ECE 617. THIN FILM TRANSISTORS. (4 Credits)
Thin-film electronics typically necessitate semiconducting materials lacking long-range order (disordered semiconductors), and hence provide a range of challenges and opportunities for device engineers. Provides a comprehensive review of the device physics and materials science of thin film electronics – in particular thin-film transistors. Provides students with the theoretical and practical knowledge to be successful in the development and study of thin film transistors, in both academic and industrial environments.
Recommended: ECE 390, ECE 416/ECE516, ECE 417/ECE 517, ECE 614

ECE 619. SELECTED TOPICS IN SOLID STATE. (3 Credits)
Special courses taught on various topics in solid state as interests and demands vary.
This course is repeatable for 99 credits.

ECE 621. RADIO FREQUENCY IC DESIGN. (3 Credits)
Radio frequency (RF) circuits. Principles, analysis, and design of bipolar and MOS RF IC building blocks: low noise amplifiers, mixers, oscillators, frequency synthesizers.
Recommended: (ECE 422 or ECE 522) and (ECE 423 or ECE 523) or ECE 520

ECE 626. ANALOG CMOS CIRCUIT DESIGN. (3 Credits)
Switched-capacitor circuit design, on-chip filters, data converters. Practical aspects of analog CMOS IC design.

ECE 627. OVERSAMPLED DELTA-SIGMA DATA CONVERTERS. (3 Credits)
Noise-shaping theory in first, second, and higher-order modulators. Design, simulation, and realization in hardware of converters using this popular architecture.

ECE 629. SELECTED TOPICS IN MICROELECTRONICS. (3 Credits)
Course work to meet student's needs in advanced or specialized areas and to introduce the newest important results in microelectronics.

ECE 659. SELECTED TOPICS IN SYSTEMS AND CONTROL. (3 Credits)
Course work to meet students' needs in advanced or specialized areas and to introduce the newest important results in systems and control.
This course is repeatable for 18 credits.

ECE 669. SELECTED TOPICS IN COMMUNICATIONS AND SIGNAL PROCESSING. (3 Credits)
Course work to meet students' needs in advanced or specialized areas and to introduce the newest important results in signal processing.
This course is repeatable for 18 credits.

ECE 679. SELECTED TOPICS IN COMPUTER ENGINEERING. (1-16 Credits)
Topics to be presented at various times include information storage and retrieval, computer architecture, fault-tolerant computing, asynchronous sequential circuits, automata, data transmission, coding theory.
This course is repeatable for 99 credits.

ECE 699. SPECIAL TOPICS. (3 Credits)
Advanced studies in field and wave theories and special devices. Topic examples are microwave and acoustic devices, advanced lasers and masers, electron beam interactions with traveling waves, MHD device dynamics.
This course is repeatable for 99 credits.