ELECTRICAL AND COMPUTER ENGINEERING

Professors Berry, Black, Brockhurst, Doering, Eccles, Ferguson, Grigg, Herniter, Hoover, Hudson, Jerse, Moore, Padgett, Rostamkolai, Simoni, Song, Voltmer, Wheeler, and Yoder.

ECE 130 Introduction to Logic Design  4R-0L-4C  F,W,S
Combination logic design, Boolean algebra, logic minimization, Karnaugh maps, static and dynamic hazards, multiplexers and memories in combinational design, flip-flops, registers and counters, finite state machine design. Use of logic simulator for several design problems.

ECE 200 Circuits & Systems  3R-3L-4C  F,S  Pre: ES 203, MA 222

ECE 250 Electronic Device Modeling  3R-3L-4C  F,S  Pre: ES 203
Modeling electrical properties of conductors, insulators, and semiconductors. Modeling of carrier transport, thermoelectric and photoelectric effects semiconductors. Static, time-dependent and temperature dependent models of diodes and transistors. Integral laboratory.

ECE 260 Engineering Practice  2R-0L-2C  F
First of a four-course sequence designed to prepare the student for professional practice with solution of open-ended problems by student teams. Effective conduct of team meetings, written and oral communication skills, time value of money, ethics and professionalism. Combination lecture/discussion group format.

ECE 300 Signals & Systems  3R-3L-4C  F,W  Pre: ECE 200

ECE 310 Communication Systems  3R-3L-4C  F,S  Pre: ECE 380
Transmission of information over bandlimited, noisy communication channels. Line codes, probability of error, intersymbol interference. Modulation techniques, synchronization and frequency conversion. Discussion of a current ethical issue. Integral laboratory.

ECE 320 Linear Control Systems  3R-3L-4C  F,S  Pre: ES 205, ECE 200

ECE 330 Digital Design Lab  2R-6L-4C  F,W  Pre: ECE 130
Laboratory projects involving logic system design using logic gates and programmable logic devices. Timing considerations, debugging techniques, use of CAD tools to perform design entry, logic
minimization, simulation, and mapping to programmable devices. Formal written reports, working in teams. Integral laboratory.

**ECE 331 Embedded System Design 3R-3L-4C F,S Pre: CS 232, ECE 350**

Microcontroller system design. Assembly language and architecture, I/O peripheral programming and interfacing, handshaking and interrupts, real-time programming, high-level programming, bus protocols, and embedded system timing analysis. Integral laboratory. Credit cannot be obtained for both ECE 331 and ECE 430.

**ECE 332 Computer Architecture II 4R-0L-4C F,S Pre: CS 232**

Pipelining, memory hierarchy, busses, instruction level parallelism, cost-performance tradeoffs, and review of new topics in areas of computer architecture or parallel processing. Team research project. Complements CS 332.

**ECE 333 Digital Systems 3R-3L-4C F,W Pre: ECE 130, ECE 200, ECE 250**

Capabilities, limitations, and design of digital (TTL/CMOS) logic devices. Design and evaluation of combinational and sequential logic circuits using programmable logic devices. Personal computer tools for design entry, timing simulation, and mapping to target devices. Troubleshooting using laboratory instrumentation. Laboratory notebooks. Informal reports. Integral laboratory.

**ECE 340 Electromagnetic Fields 4R-0L-4C F,W Pre: ES 203, MA 222**

Behavior of resistors, capacitors, inductors, magnetic circuits, and relays in terms of electromagnetic fields; field intensities, potential gradients, line integrals, flux densities, surface integrals; constituent properties; incremental elements; numeric and analytic solution techniques; energy and power; technical reports that extend basic concepts of the course.

**ECE 341 Electromagnetic Waves 4R-0L-4C F,S Pre: ECE 340**

Distributed parameters; Maxwell’s equations; quasistatic analysis, TEM plane waves in space, power flow, lossy materials, reflections; steady-state reflection coefficients, impedance, VSWR, Smith chart, transmission line matching techniques.

**ECE 350 Electronics & Interfacing 3R-3L-4C W,S Pre: ECE 200, ECE 330**

Diode, BJT, and MOSFET theory, modeling, switching applications, common transducers, A/D and D/A conversion, analog applications. Integral laboratory.

**ECE 351 Analog Electronics 3R-3L-4C F,W Pre: ECE 200, ECE 250**

Diode, BJT, FET, and operational amplifier models and circuits. Specifications for circuit design including frequency response, terminal impedance and signal characteristics, feedback, and gain. Design, analysis, fabrication, and testing of analog linear and nonlinear electronic circuits such as power supplies and active bias networks. Integral laboratory.

**ECE 360 Principles of Design 2R-6L-4C W,S Pre: Junior standing, ES 205, ECE 260 and at least three of the other EE or CpE core courses Co: RH 330**
Second formal design sequence that emphasizes the design process. Project management, project reporting and decision-making are learned by student teams as they carry a project from inception through conceptual design. Integral laboratory.

**ECE 370 Machines & Power 3R-3L-4C W,S Pre: ECE 300, ECE 340**


**ECE 380 Discrete Time & Continuous Systems 4R-0L-4C W,S Pre: ECE 300**


**ECE 398 Undergraduate Projects 1-4C Arranged Pre: Consent of instructor**

Special design or research projects.

**ECE 410 Communication Networks 4R-0L-4C Pre: Senior standing or consent of instructor**


**ECE 414 Wireless Systems 4R-0L-4C Pre: ECE 310**

Introduction to mobile radio communications with application to cellular telephone systems, wireless networks, and personal communication systems. System design, propagation, modulation, spread spectrum, coding, and multiple-access techniques.

**ECE 415 Wireless Electronics 2R-6L-4C Pre: Consent of instructor**

Design, fabrication, and testing of a high frequency transmitter-receiver system including but not limited to oscillators, mixers, filters, amplifiers, and matching networks. Integral laboratory.

**ECE 420 Nonlinear Control Systems 3R-3L-4C Pre: ECE 320**

Modeling nonlinear systems. Use of modeling software to design nonlinear control systems. Intuitive control strategies. Fuzzy control, computer and hardware implementation of fuzzy controllers, adaptive fuzzy control. Integral laboratory.

**ECE 430 Microcomputers 3R-3L-4C Pre: ECE 130**

ECE 442  High-Speed Digital Design  3R-3L-4C  Pre: ECE 200

Distributed-circuit effects in high-speed switching circuits. Transient behavior of transmission lines is introduced, leading to such topics as interfacing reactive and nonlinear elements, design of circuit-board transmission lines, electromagnetic coupling, and signal integrity. Integral laboratory.

ECE 451  Nonlinear Electronics  3R-3L-4C  Pre: ECE 351

Analysis and design of Class C and D amplifiers, high-power switching amplifiers, negative-resistance oscillators, low-noise transistor and operational amplifier circuits, and parametric amplifiers. Emphasis on nonlinear and time-varying circuit analysis and design techniques. Integral laboratory.

ECE 452  Power Electronics  3R-3L-4C  Co: ECE 351

Analysis and design of networks that use electronic devices as power switches. Silicon-controlled rectifiers, power transistors, and power MOSFETS are used to form phase-controlled rectifiers, AC voltage controllers, choppers, and inverters. Integral laboratory.

ECE 460  Engineering Design I  2R-6L-4C  F,W  Pre: ECE 360, senior standing and completion of at least seven of the EE or CpE core courses.

The third in a sequence of formal design courses that emphasizes completion of a client-driven project using the design process. Student teams carry a project from inception to completion to satisfy the need of a client. Integral laboratory.

ECE 461  Engineering Design II  4R-6L-6C  W,S  Pre: ECE 460

Continuation of the design project from ECE 460. Offered over two terms; no credit will be granted for the first term alone. Six credits will be granted after completion of the second term. Integral laboratory.

ECE 466  Consulting Engineering Seminar  2R-0L-2C  Pre: Junior class standing

Discussion problems in the field of consulting engineering; seminars presented by practicing consulting engineers.

ECE 470  Power Systems I  3R-3L-4C  Pre: ECE 370


ECE 471  Industrial Power Systems  4R-0L-4C  Pre: ECE 370

Design and analysis techniques for low and medium voltage power distribution systems. Harmonics, transients, system coordination, reliability and economics. A design project is carried throughout the course.

ECE 472  Power Systems II  3R-3L-4C  Pre: ECE 470
Power system protection and stability. Design and application of relaying schemes for protection of transformers, buses, distribution lines, transmission lines, generators, motors, capacitors, and reactors. Power system stability and generator rotor dynamics phenomenon with use of the equal-area criterion. Integral laboratory.

ECE 480/PH 437 Introduction to Image Processing 3R-3L-4C Pre: MA 222 and Junior standing

Basic techniques of image processing. Discrete and continuous two-dimensional transforms such as Fourier and Hotelling. Image enhancement through filtering and histogram modification. Image restoration through inverse filtering. Image segmentation including edge detection and thresholding. Introduction to image encoding. Integral laboratory. Same as PH 437.

ECE 481 Electronic Music Synthesis 4R-0L-4C Pre: ECE 280 or ECE 380


ECE 497 Special Topics in Electrical Engineering 1-4C arranged Pre: Consent of instructor and department head

Topics of current interest to undergraduate students.

ECE 498 Engineering Projects and Design 2R-6L-4C Pre: Senior standing

Aspects of design and design presentations. Development of preliminary design and proposal for hardware project. Formal proposal and component selection. Construction, testing, and performance demonstration of previously designed project. Formal final report and oral presentation.

UNDERGRADUATE-GRADUATE COURSES

ECE 510 Error Correcting Codes 4R-0L-4C Pre: Senior standing or consent of instructor

Coding for reliable digital communication. Topics to be chosen from: Hamming and BCH codes, Reed-Solomon codes, convolutional codes, Viterbi decoding, turbo codes, and recent developments, depending on interests of class and instructor. Mathematical background will be developed as needed.

ECE 511 Data Communications 4R-0L-4C Pre: ECE 310, MA 223 or MA 381

Design of digital communication systems. Topics to be chosen from: Channel characterization, data compression and source coding, baseband data transmission, noise modeling, probability of error, optimal receiver structures, modulation methods, synchronization.

ECE 520 Control Systems I 3R-3L-4C Pre: ECE 320


ECE 521 Control Systems II 3R-3L-4C Pre: ECE 320
State variable modeling of physical systems. Lagrangian formulations, applications of linear algebra, controllability, observability, state feedback design, design of observers. Laboratory projects emphasize control system design using state variable methods. Integral laboratory.

**ECE 530 Advanced Microcomputers 3R-3L-4C Pre: ECE 430**


**ECE 531 Microprogrammable Microcomputers 3R-3L-4C Pre: ECE 430**

Architecture and application of microprogrammed CPU□s. Microprogrammed control, hardwired control. Students will be required to develop their own microprogrammed CPU. Integral laboratory.

**ECE 532 Advanced Computer Architecture 4R-0L-4C Pre: ECE 332 or both ECE 530 and ECE 531**

Selected topics in computer architecture depending on interests of class and instructor. Projects investigating current issues in computer architecture.

**ECE 533 Programmable Logic System Design 3R-3L-4C Pre: ECE 330 or ECE 333 or consent of instructor**

Digital system-on-chip design techniques, including an advanced hardware description language, testbenches and verification, area and timing optimization, embedded microprocessors, and design for testing. Integral laboratory using contemporary CAD tools and FPGA devices.

**ECE 540 Antenna Engineering 3R-3L-4C Pre: ECE 341**

Electromagnetic radiation, antenna terminology and characteristics, dipole antennas, arrays, aperture antennas, measurements, computer-aided analysis, design projects and reports.

**ECE 541 Microwave/Millimeter-Wave Engineering 4R-0L-4C Pre: ECE 341**

Wave-guide structures, scattering parameters, passive components, active components, computer-aided design of amplifiers, oscillators and mixers, microwave/millimeter-wave systems, microwave and millimeter-wave integrated circuits.

**ECE 542 Advanced Electromagnetics 4R-0L-4C Pre: ECE 341**

Maxwell□s equations, power and energy, material properties, waves, reflections, radiation, EM field theorems, boundary value problems, skin effect.

**ECE 543 Mathematical Methods of Electromagnetics 4R-0L-4C Pre: ECE 341**

Perturbational and variational techniques, moment methods, integral equation and Wiener-Hopf techniques, development of computer programs.

**ECE 550 Linear Active Networks 3R-3L-4C Pre: ECE 351**

**ECE 551 VLSI I: Design and Testing  3R-3L-4C  Pre: ECE 333 or ECE 330, and ECE 350 or ECE 351**

Design, performance analysis, and physical layout of CMOS logic. Custom and standard cell methodologies. Use of commercial CAD tools. Design issues in VLSI such as interconnect, timing, and testing methods. Integral laboratory and project.

**ECE 552 VLSI II: Mixed-Signal IC Design  3R-3L-4C  Pre: ECE 551**

Design, performance analysis, and physical layout of basic analog building blocks. Mixed-signal circuit design. Discussion of issues related to placing both analog and digital circuits on a single substrate. Integral laboratory and design project.

**ECE 553 Advanced Topics in VLSI  3R-3L-4C  Pre: ECE 551**

Advanced topics in integrated circuit design. Discussion of leading-edge technologies. Topics could include memory design, sense amps, I/O pad design, MEMS, low- and high-power circuit design, and low-voltage circuit designs. Classroom presentations, informal reports. Integral laboratory.

**ECE 554 Instrumentation  4R-0L-4C  Pre: ECE 351**

Transducers and their applications. Instrumentation amplifiers. A/D and D/A converters. Shock protection. Generation, recording and analysis of biological potentials (ECG, EMG, EEG). Ultrasound techniques and instrumentation. X-ray CAT techniques. Project involving the design of a significant instrument will run throughout the course. No laboratory, but emphasis on computer simulation of the circuits studied.

**ECE 571 Control of Power Systems  3R-3L-4C  Pre: ECE 470**


**ECE 580 Digital Signal Processing  4R-0L-4C  Pre: ECE 380 or consent of instructor. MA 310 recommended**


**ECE 581 Digital Signal Processing Projects  2R-2L-2 or 4C  Pre: ECE 580 or concurrent registration**

Computer-aided design of digital filters and other DSP modules. Software and hardware realization using modern DSP chips. DSP chip architectures, assembly and C-language programming, and
interfacing techniques. Optional advanced project may be done to earn four credit hours; otherwise two credit hours are given. Integral laboratory.

**ECE 582/PH 537  Advanced Image Processing  3R-3L-4C  Pre: ECE 480 or PH 437**

Introduction to color image processing and image recognition. Morphological methods, feature extraction, advanced segmentation, detection and registration, recognition and interpretation. Integral laboratory. Same as PH 537.

**ECE 597  Special Topics in Electrical Engineering  4C  Pre: Consent of instructor**

Special topics of current interest to graduate students and senior undergraduates.

**ECE 598  Thesis Research  1-4C  arranged**

Thesis topic selected in consultation with adviser. Graduate students only.

**SERVICE COURSES**

**ECE 206  Elements of Electrical Engineering I  4R-0L-4C  F,W,S  Pre: MA 221**

A course designed for engineers (other than electrical or computer) covering analysis of passive DC circuits, introduction to digital circuits, steady-state sinusoidal circuit analysis and power in AC systems. EE or CPE majors may not take this course as a free elective.

**ECE 207  Elements of Electrical Engineering II  4R-0L-4C  W,S  Pre: ES 203**

A course designed for engineers (other than electrical or computer) covering transient response of passive circuits, analog devices and systems, power devices, motors and systems. EE or CPE majors may not take this course as a free elective.

**ECE 466  Consulting Engineering Seminar  2R-0L-2C  Pre: Junior class standing**

Discussion problems in the field of consulting engineering; seminars presented by practicing consulting engineers.

**Area Minor in Electrical and Computer Engineering (ECE)**

The Area Minor in ECE is designed to allow students to add another dimension to their Rose-Hulman degree.

Advisor Dr. Fred Berry

**Requirements for Area Minor in ECE**

ES 203 (the prerequisite of ES 201 is waived for all majors except ME)
ECE 200
Plus four additional ECE courses, except ECE 260, ECE 360, ECE 460, ECE 461, ECE 466, ECE 497, ECE 498, ECE 206, and ECE 207

**Example Area Minor for Physics and Applied Optics**
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<tr>
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<th>Credits</th>
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<tbody>
<tr>
<td>ECE 200</td>
<td>Circuits and Systems</td>
<td>4</td>
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<tr>
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<td>Signals and Systems</td>
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<td>ECE 380</td>
<td>Discrete Time and Continuous Systems</td>
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<td>ECE 310</td>
<td>Communication Systems</td>
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<td>ECE 414</td>
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**Example Area Minor for Computer Science**

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<tr>
<td>ECE 130</td>
<td>Intro to Logic Design</td>
<td>4</td>
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<tr>
<td>ES 203</td>
<td>Required Electrical Systems</td>
<td>3</td>
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<tr>
<td>ECE 200</td>
<td>Circuits and Systems</td>
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<tr>
<td>ECE 330</td>
<td>Digital Design Laboratory</td>
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<td>ECE 332</td>
<td>Computer Architecture II</td>
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<tr>
<td>ECE 350</td>
<td>Electronics Interfacing</td>
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**Example Area Minor for Mechanical Engineering**

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<td>ECE 340</td>
<td>Electromagnetic Fields</td>
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<td>ECE 370</td>
<td>Machines and Power</td>
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