

ELECTRICAL AND COMPUTER ENGINEERING (ECE)

Subject-area course lists indicate courses currently active for offering at the University of Louisville. Not all courses are scheduled in any given academic term. For class offerings in a specific semester, refer to the Schedule of Classes (https://csprd.louisville.edu/psp/ps_class/EMPLOYEE/PSFT_CS/c/COMMUNITY_ACCESS.CLASS_SEARCH./x/?state=62dab551a0d600a5e8237359c50704e59007&duo_code=sjUx20STj21bWVEuQ3Z1YRjHmfXpgoV)

500-level courses generally are included in both the undergraduate- and graduate-level course listings; however, specific course/section offerings may vary between semesters. Students are responsible for ensuring that they enroll in courses that are applicable to their particular academic programs.

Course Fees

Some courses may carry fees beyond the standard tuition costs to cover additional support or materials. Program-, subject- and course-specific fee information can be found on the Office of the Bursar website (<https://louisville.edu/bursar/tuitionfee/university-fees/>).

ECE 500. Special Topics in Electrical Engineering 1-6 Units

Term Typically Offered: Fall, Spring, Summer

Description: Exploration of one or more ECE topics not covered in the regular course offerings.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 505. Graduate-Professional Project in Electrical Engineering 1-6 Units

Term Typically Offered: Fall, Spring, Summer

Prerequisite(s): Approval of a faculty sponsor.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 510. Computer Design 3 Units

Term Typically Offered: Fall, Spring

Prerequisite(s): ECE 210.

Corequisite(s): ECE 511.

Description: Review of logic design and elementary computer organization. Design of the central processing unit, memory, control, and input-output portions of a computer. The VHDL hardware design language will be used.

Note: Cross-listed with CSE 510.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 511. Computer Design Laboratory 1 Unit

Term Typically Offered: Fall, Spring

Prerequisite(s): ECE 210.

Corequisite(s): ECE 510 or CECS 510.

Description: Experiments in the design of the central processing unit, memory, control, and input-output portions of a computer using VHDL for software simulation.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 514. Introduction to VLSI Systems Laboratory 1 Unit

Term Typically Offered: Occasionally Offered

Prerequisite(s): ECE 510 (or concurrent) or CECS 510 (or concurrent) or consent of instructor.

Corequisite(s): ECE 515.

Description: Design of logic circuits and subsystems using CAD tools: layout, verification, parameter extraction, circuit- and logic-level simulation.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 515. Introduction to VLSI Systems 3 Units

Term Typically Offered: Occasionally Offered

Prerequisite(s): ECE 510 (or concurrent) or CECS 510 (or concurrent) or consent of instructor.

Corequisite(s): ECE 514.

Description: MOS devices and circuits, electrical and logic design principles. Fabrication steps, design rules, electrical parameters, extraction, delays. Logic/switch arrays, dynamic precharge logic, precharge forms, finite state machines, registers, memories, subsystem design examples.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 516. Microcomputer Design 4 Units

Term Typically Offered: Fall, Spring, Summer

Prerequisite(s): ECE 412 or CECS 412 or consent of instructor.

Description: Design and construction of microcomputers with microprocessors and digital integrated circuits. Breadboarding, hardware design and software design are emphasized. The class is separated into groups and each group designs, breadboards and tests a complete microcomputer system including interfaces to peripheral devices.

Note: Cross-listed with CECS 525.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 518. Fundamentals of Computer Communications and Networks

3 Units

Term Typically Offered: Fall, Spring

Prerequisite(s): ECE 360 or IE 360, and CSE 412.

Description: Data communications: The exchange of data between devices is covered. The key aspects of transmission interfacing, link control, and multiplexing are examined. Data communication networking: Examines the internal mechanisms by which communication networks provide a data transfer service for attached devices.

Note: Cross-listed with CSE 516.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 520. Digital Signal Processing

3 Units

Term Typically Offered: Fall, Spring

Prerequisite(s): ECE 420.

Corequisite(s): ECE 521.

Description: Discrete time signals and systems; Discrete Fourier Transforms, FFT algorithms, flow graph and the matrix representation of digital filters; FIR and IIR filter design techniques; quantization effects; spectral estimation; current applications of digital signal processing.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 521. Digital Signal Processing Laboratory

1 Unit

Term Typically Offered: Fall, Spring

Prerequisite(s): ECE 420.

Corequisite(s): ECE 520.

Description: Focuses on the implementation of common digital signal processing functions using state-of-the-art DSP devices and software. Introduction to fundamentals of discrete-time signal processing and digital signal processor architectures and applications. Emphasis on laboratory experience involving generation of deterministic and random signals; digital filter design; quantization effects; FFT computation; linear system analysis; speech processing.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 523. Introduction to Biometrics

3 Units

Term Typically Offered: Fall, Spring, Summer

Prerequisite(s): ECE 420 and Senior standing.

Description: Biometric approaches aim at identification based on a physical characteristic. Survey of biometric techniques with focus on non-intrusive approaches. Topics covered include image formation, sensors, motion tracking, and face recognition algorithms.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 526. LabVIEW for Electrical Engineers

3 Units

Term Typically Offered: Fall, Spring, Summer

Prerequisite(s): ECE 420 (or concurrent) or permission from the instructor.

Description: Introduction to capabilities of LabVIEW software for electrical engineers. Weekly labs build mastery of LabVIEW applications such as: data acquisition and analysis, instrumentation, and DSP programming.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 528. Deep Learning and AI Tools

3 Units

Term Typically Offered: Spring Only

Prerequisite(s): ENGR 330 or ENGR 307.

Corequisite(s): ECE 529.

Description: Machine learning basics. Supervised and unsupervised learning. Feedforward networks, error back propagation algorithm; linear, nonlinear, logistic and softmax regression, regularization. Autoencoders, sparsity and feature learning under constraints. Convolutional nets. Recurrent networks, backpropagation through time, LSTM.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 529. Deep Learning and AI Tools Laboratory

1 Unit

Term Typically Offered: Spring Only

Prerequisite(s): ENGR 330 or ENGR 307.

Corequisite(s): ECE 528.

Description: Lab course for ECE 528 Deep Learning and AI Tools

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 530. Introduction to Random Processes and Estimation Theory

3 Units

Term Typically Offered: Fall, Spring, Summer

Prerequisite(s): ENGR 330; ECE 360 or IE 360; and ECE 420.

Description: Introduction to the theory and applications of random processes, a nonmeasure-theoretic approach to the study of random variables, functions of random variables, least square estimation, convergence, stochastic representation, stationarity, ergodicity, Gaussian processes, Poisson processes, Markov chains, and random fields.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 531. Power Electronics

3 Units

Term Typically Offered: Fall, Spring, Summer

Prerequisite(s): ECE 333, ECE 334, and ECE 420.

Description: Topics in power electronics including: power semiconductor devices; converter topologies and their applications; switched-mode DC and uninterruptible power supplies; motor drives; EMI concerns and remedies for interfacing to electric utilities.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 532. Electromechanical System Designs for Home Appliances

4.5 Units

Term Typically Offered: Fall, Spring, Summer

Description: An integrated study of advanced electrical engineering and software engineering fundamentals and their application to technologies associated with the design, development, and production of modern major household appliances. This class is designed for GE Appliances Edison students or GE Appliances employees enrolled in the ECE program.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 533. Integrated Circuit Design Term Typically Offered: Spring Only Prerequisite(s): ECE 333. Corequisite(s): ECE 534. Description: Analysis and design of analog integrated circuits. Bipolar, JFET, and MOS-FET devices. The technology of IC fabrication. Transistor connections, current sources, active loads, and output stages. Integrated amplifier and MOS circuit design. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units	ECE 544. Microfabrications/MEMS Laboratory Term Typically Offered: Fall, Spring, Summer Prerequisite(s): ECE 543 (or concurrent). Fee: An additional \$250.00 is charged for this course. Description: Laboratory to illustrate microfabrication processes, semiconductor measurement techniques, MEMS microstructure fabrication, and MEMS testing. Cleanroom activity required. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	1 Unit
ECE 534. Integrated Circuit Design Laboratory Term Typically Offered: Spring Only Prerequisite(s): ECE 333. Corequisite(s): ECE 533. Description: Laboratory to illustrate design principles in ECE 533. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	1 Unit	ECE 545. Optical Signal Processing Term Typically Offered: Fall, Spring, Summer Prerequisite(s): ECE 420 or consent of instructor. Description: Scalar diffraction theory and equivalence to linear filtering. Fourier transform properties of lenses. The modulation transfer function. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units
ECE 539. Industrial Software for Home Appliances Description: This course provides electrical engineering graduate students working in the major home appliance industry with an understanding of industrial software engineering fundamentals and their application to technologies associated with the design, development, and production of major household appliances such as refrigerators, washers, dryers, cooking products and dishwashers. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	4.5 Units	ECE 546. Introduction to Medical Imaging Term Typically Offered: Fall, Spring, Summer Prerequisite(s): ECE 420. Description: Focuses on the foundation of modern medical imaging at an introductory level with emphasis placed on concepts: X-ray, CT, MRI, PET, and Ultrasound will be discussed. Students interested in in-depth treatment of these topics should register for ECE 641. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units
ECE 542. Semiconductor Device Fundamentals Term Typically Offered: Fall, Spring Prerequisite(s): ENGR 205 or MATH 405. Description: Semiconductor fundamentals, energy bands, carrier transport theory, continuity equations, PN junction diodes, Zener diodes, MOS capacitors, MOSFETs, microelectronic fabrication, and select other topics. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units	ECE 550. Communication and Modulation Term Typically Offered: Spring Only Prerequisite(s): ECE 360 or IE 360, and ECE 420. Corequisite(s): ECE 551. Description: Modulations such as AM, FM, PAM, PPM, PDM, single sideband, vestigial sideband. Coherent and noncoherent detection, heterodyne action, performance and distortion, circuits for modulation and demodulation For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units
ECE 543. Fundamentals of Microfabrication and MEMS Term Typically Offered: Fall, Spring, Summer Prerequisite(s): Senior standing. Description: Microfabrication techniques including cleanroom technology, lithography, thermal oxidation, diffusion, ion implantation, film deposition, etching, micromachining, wafer-level bonding/polishing, and packaging yield. Microtechnology measurement and analysis techniques. Process simulation. CAD device-layout. MEMS (microelectromechanical systems) and microelectric technology and applications. Material issues for MEMS/microelectronics. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units	ECE 551. Communication Systems Laboratory Term Typically Offered: Spring Only Prerequisite(s): ECE 420. Corequisite(s): ECE 550. Description: Laboratory exercises involving the design and analysis of electronic communication systems for the transmission of analog and digital data at radio frequencies. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	1 Unit

<p>ECE 555. Digital Image Processing 3 Units Term Typically Offered: Fall, Spring Prerequisite(s): ECE 520 and ECE 521, or ECE 420 and departmental consent. Corequisite(s): ECE 556. Description: Introduction to the theory and applications of 2-D signal and image processing: 2-D signals and systems analysis, 2-D sampling and quantization, 2-D signals and image transforms, 2-D FIR filter design; image formation; image enhancement; image restoration; image coding; image reconstruction from projections; image compression; color image processing; current applications. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>	<p>ECE 565. Fundamentals of Autonomous Robots Lab 1 Unit Term Typically Offered: Fall Only Prerequisite(s): Senior standing, or permission of instructor. Corequisite(s): ECE 564. Description: An autonomous robots laboratory experience in which the student becomes familiar with designing and building autonomous robots, using sensors, applying robotic paradigms and controller design. A final robotic competition will be held at the end of the semester. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>
<p>ECE 556. Digital Image Processing Laboratory 1 Unit Term Typically Offered: Fall, Spring Corequisite(s): ECE 555. Description: Laboratory experiments in software are assigned to test the concepts covered in ECE 555, Digital Image Processing. Projects include: Image Representation and Transformation, Image Enhancement in the spatial and frequency domain and Image Restoration. Time permitting, projects on image compression and image segmentation will also be assigned. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>	<p>ECE 569. Intermediate Electromagnetic Fields and Waves 3 Units Term Typically Offered: Fall, Spring, Summer Prerequisite(s): ECE 473. Description: General curvilinear coordinates. Electromagnetic energy transmission. The wave equation, Poynting theorem and plane wave propagation in media. Transmission lines and impedance matching. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>
<p>ECE 560. Control Systems Principles 3 Units Term Typically Offered: Fall, Spring, Summer Prerequisite(s): ECE 420. Corequisite(s): ECE 561. Description: Basic concepts of linear control systems. Formulation of the linear control problem by classical and state space methods. Frequency response and time response analysis and synthesis techniques. Stability and system performance specifications. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>	<p>ECE 581. Electric Machines and Drives 3 Units Term Typically Offered: Fall, Spring, Summer Prerequisite(s): ECE 473. Description: Operating principles and characteristics of DC, induction, synchronous motors/generators. AC/DC electric-machine drives for speed/position control. Integrated discussion of electric machines, power electronics, and control systems. B and H in ferromagnetic materials. Magnetic circuits. Transformers. Dynamic equations of magnetic systems. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>
<p>ECE 561. Control Systems Laboratory 1 Unit Term Typically Offered: Fall, Spring, Summer Corequisite(s): ECE 560. Description: Laboratory exercises involving identification, analysis and design of closed-loop control systems. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>	<p>ECE 582. Power System Analysis 3 Units Term Typically Offered: Fall, Spring, Summer Prerequisite(s): ECE 473. Description: Three-phase circuits. Inductance and capacitance of transmission lines. Circuit models. Per-unit representation. Network methods. Load-flow studies. Load-flow control. Economic dispatch. Symmetrical three-phase faults. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>
<p>ECE 564. Fundamentals of Autonomous Robots 3 Units Term Typically Offered: Fall Only Prerequisite(s): Senior standing, or permission of instructor. Corequisite(s): ECE 565. Description: Fundamentals of autonomous robots: sensors, path planning, machine perception, basic principles of AI, modeling, control and architecture. Case studies in industry and medicine will be discussed. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>	<p>ECE 593. Independent Study in Electrical Engineering 1-6 Units Term Typically Offered: Fall, Spring, Summer Prerequisite(s): Approval of a faculty sponsor. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>
	<p>ECE 595. Graduate/Professional Seminar in Electrical & Computer Engineering 1 Unit Term Typically Offered: Fall, Spring, Summer For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>

ECE 600. Special Topics in Electrical & Computer Engineering 1-6 Units

Description: An examination of one or more specific areas of Electrical and/or Computer Engineering not covered in the regular curriculum.

Topics vary by semester.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 602. Graduate Internship in Electrical and Computer Engineering 2 Units

Grading Basis: Pass/Fail

Term Typically Offered: Fall, Spring, Summer

Prerequisite(s): Admission to Graduate Study, Permission of Department Chair, and Permission of Director of Career Services.

Description: Supervised professional experience in industry at the graduate level. This course provides the structure and focus for the graduate intern field assignment to ensure that the assignment is appropriate and consistent with the intern's graduate course of study and professional development. Not to be counted towards meeting the requirements for a degree. May be repeated for credit.

Course Attribute(s): CBL - This course includes Community-Based Learning (CBL). Students will engage in a community experience or project with an external partner in order to enhance understanding and application of academic content.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 605. Graduate Project in Electrical & Computer Engineering 1-6 Units

Prerequisite(s): Approval of a faculty sponsor.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 611. Computer Architecture 3 Units

Term Typically Offered: Fall Only

Prerequisite(s): Any of the following: CECS 510, CECS 525, ECE 510, ECE 516 or equivalent.

Description: This course will provide in-depth exposure to advanced topics in computer architecture. The emphasis is on studying and analyzing fundamental issues in computer architecture design and their impact on performance. Course topics include performance measurements; ISA; memory hierarchy design and cache memory; advanced pipelining; and advanced computer structures for instruction-level parallelism, instruction scheduling, data-level parallelism, and thread-level parallelism.

Note: Cross-listed with CECS 611.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 613. Computational Intelligence Methods for Data Analysis 3 Units

Prerequisite(s): Graduate standing.

Description: Foundations of neural processing, fuzzy systems, genetic algorithms, and machine learning. Theory and application of Principal and Independent Component Analysis. Applications for classification, clustering, visualization, data mining, rule generation, and expert systems.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 614. Deep Learning 3 Units

Description: Machine learning basics. Supervised and unsupervised learning. Feedforward neural networks, error back propagation algorithm, logistic and softmax regression, regularization. Auto-encoders, sparsity and feature learning under constraints Convolutional nets. Boltzmann machines.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 618. Artificial Intelligence Systems 3 Units

Term Typically Offered: Occasionally Offered

Description: The course provides an in-depth overview of the modern theory, algorithms, and sample applications of artificial intelligence, in a systems-based approach. Theoretical concepts include predicate calculus logic, heuristic search, language models, and knowledge representations. Algorithms include machine learning using convolutional neural networks, deep learning, reinforcement learning, and transfer learning.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 619. Computer Vision 3 Units

Term Typically Offered: Spring Only

Prerequisite(s): ECE 555 or ECE 618.

Corequisite(s): ECE 645.

Description: Introduction to the theory and applications of computer vision. Topics include: image representation, image segmentation, image analysis by mathematical morphology, texture, shape representation, shape analysis and 3D vision.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 620. Pattern Recognition and Machine Intelligence 3 Units

Term Typically Offered: Fall, Spring

Prerequisite(s): ECE 420 and ECE 360 or IE 360.

Corequisite(s): ECE 655.

Description: Fundamentals of statistical, structural, and syntactic pattern recognition approaches. Parametric and nonparametric classification, feature extraction, clustering, and formal languages representation. Applications include: Data classification, character recognition, speech recognition, and target tracking.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

ECE 631. Advanced Electromechanical System Design for Home Appliances 4.5 Units

Description: Provides electrical engineering graduate students working in the major home appliance industry with an advanced, integrated summary of electrical engineering and computer engineering fundamentals presented in the context of technologies impacting appliance product lines and production methodologies. Curriculum materials and assignments emphasize the multi-disciplinary nature of these technologies, and critical role played by EE / CE in their realization. The course culminates in an end-of-semester project, which the students will work together to solve a real-world engineering problem from the major home appliance industry.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

<p>ECE 632. Semiconductor Principles 3 Units Prerequisite(s): ECE 542 and ECE 473. Description: Fundamental principles of semiconductors necessary for a detailed understanding of the operation of transistors, including energy bands, carrier statistics, recombination-generation, carrier transport, and Boltzmann equation. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>		<p>ECE 641. Medical Imaging Systems 3 Units Prerequisite(s): ECE 555 or ECE 618. Description: Focuses on the foundations of; modern medical imaging. Topics include: X-ray generation and X-ray/tissue interactions, projection X-ray imaging, image reconstruction from projections, X-ray CT, MRI, nuclear medicine, SPECT, PET, and Ultrasound. Note: Cross-listed with CSE 641. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>	
<p>ECE 633. Microelectronics Design and Fabrication 4 Units Term Typically Offered: Spring Only Prerequisite(s): ECE 542, ECE 543 and ECE 544. Fee: An additional \$250.00 is charged for this course. Description: Design, layout, simulation and verification, fabrication, characterization, and extraction of model parameters for microelectronic devices (e.g., MOSFETs) and circuits. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>		<p>ECE 643. Introduction to Biomedical Computing 3 Units Prerequisite(s): Graduate Standing. Description: Covers various aspects of modern tools of biocomputing in its broad sense; hardware and software issues are covered. Topics include: Super and high performance computer architecture, high bandwidth networking, wireless computing, visualization, and software engineering in medicine. Topics also include computer-assisted interventions, imaging, parallel programming, and database design and query, as applied to life, medical and biomedical sciences. Note: Formerly cross-listed with CECS 643. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>	
<p>ECE 636. MEMS Design and Fabrication 4 Units Term Typically Offered: Spring Only Prerequisite(s): ECE 543 and ECE 544. Fee: An additional \$250.00 is charged for this course. Description: Design, layout, simulation and verification, fabrication, characterization, and extraction of model parameters of MEMS devices. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>		<p>ECE 645. Computer Vision Laboratory 1 Unit Term Typically Offered: Spring Only Prerequisite(s): ECE 555 or ECE 618. Corequisite(s): ECE 619. Description: Laboratory experiments in hardware and software forms are assigned to test the concepts covered in ECE 619, Computer Vision. Projects include: Image formation and camera calibration, stereo vision, 3D object reconstruction from the sequence of images, active vision applications, surface registration, and motion estimation. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>	
<p>ECE 638. The MOSFET 3 Units Prerequisite(s): ECE 542. Description: Fundamentals of MOSFET operation and fabrication, including long-channel MOSFET's, short-channel MOSFET's, sub-100nm gate-length MOSFET's, and novel MOSFET structures. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>		<p>ECE 651. Communication System Design 3 Units Prerequisite(s): ECE 550. Description: Emphasis on the systems approach to digital communication systems design. Topics include communication link analysis, channel coding, modulation and coding trade-offs, synchronization, spread spectrum techniques, and data encryption and decryption. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>	
<p>ECE 639. Advanced Industrial Software for Home Appliances 4.5 Units Description: Provides electrical engineering graduate students working in the major home appliance industry with an understanding of industrial software engineering fundamentals and their application to technologies associated with the design, development, and production of major household appliances such as refrigerators, washers, dryers, cooking products and dishwashers. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>		<p>ECE 652. Information Theory and Coding 3 Units Prerequisite(s): ECE 550. Description: Information theory, capacity, and measures of information; fixed and variable length block encoding, data compression; state transition and Markov source models for communication channels and methods of achieving maximum capacity; topics in abstract algebra including groups, rings and fields; block error correction codes such as Hamming codes, cyclic codes, BCH codes, Reed Solomon codes; convolutional codes and Viterbi decoding algorithm. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>	
<p>ECE 640. Introduction to Biomedical Engineering 3 Units Prerequisite(s): ECE 420. Description: Engineering modeling and simulation of biological systems, quantitative physiology of the cardiovascular, pulmonary, and circulation systems, fundamentals of biomechanics and human-machine interface, basics of medical instrumentation design, and artificial organs. Practical applications include biopotential amplifiers design, biological signal processing, and medical imaging. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)</p>			

- ECE 653. Digital Communications** 3 Units
Prerequisite(s): ECE 550 and ECE 360 or IE 360.
Description: Review of random process theory, sampling and quantization, source coding, optimum receivers for AWGN channels, digital transmission through band-limited AWGN channels, inter-symbol interference, equalization, and spread spectrum systems. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 654. Advanced Voice/Data Networks** 3 Units
Prerequisite(s): ECE 518 or CECS 516 or permission of the instructor.
Description: This course extends topics covered in ECE 518 to address advanced networking technologies that are used in corporate intranets and the Internet. Topics covered include: packet-voice technologies, Ethernet switching, IP version 6, digital subscriber loop technologies, dynamic routing, tagged packet switching technologies, and Quality of Service (QoS). For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 655. Pattern Recognition and Machine Intelligence Laboratory** 1 Unit
Term Typically Offered: Fall, Spring
Corequisite(s): ECE 620.
Description: Laboratory experiments in hardware and software forms are assigned to test concepts covered in ECE 620, Pattern Recognition and Machine Intelligence. Projects include: Stochastic simulation, design of Bayesian classifiers, clustering, hyperspectral classifiers, digital train mapping, automatic target recognition, and biomedical applications. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 656. Wireless Communications and Mobile Radio Networks** 3 Units
Term Typically Offered: Occasionally Offered
Prerequisite(s): ECE 550 This class discusses the modern view of broadband wireless communication systems and their associated challenges.
Description: The class will cover the latest concepts and developments in the field. Emphases will be placed on enabling technologies such as OFDM, MIMO and their applications in the latest WiFi and mobile cellular networks. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 660. Introduction to Robust Control** 3 Units
Prerequisite(s): ECE 560 and ECE 561.
Description: To provide students with the fundamentals of Robust Control Theory, with emphasis on stability and performance analysis in the time and frequency domains and design tools for robust performance and robust stability. It examines how a controller can be designed taking into account uncertainties in the model of the plant. The course will include a final design project which will be completed using MATLAB. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 661. Sampled-Data Control Systems** 3 Units
Prerequisite(s): ECE 560.
Description: Analysis and synthesis of closed-loop sampled-data control systems using Z-transforms and state-space methods. Sampling and data reconstruction. Modified Z-transform. Time response and steady state accuracy. Stability analysis. Lag, lead, and PID controllers. Pole assignment. State estimation. Discrete optimal control. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 662. Introduction to Optimum Control** 3 Units
Prerequisite(s): ECE 560.
Description: Calculus of variations, dynamic programming, the minimum principle, and numerical optimization techniques applied to discrete-time and continuous-time deterministic control systems. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 664. Modern Adaptive Control** 3 Units
Prerequisite(s): ECE 560 and ECE 625.
Description: Methods of modern adaptive control, including the indirect and direct approaches. Discrete- and continuous-time controllers. Behavior of controllers under nonideal conditions, including stochastic disturbances and unmodeled dynamics. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 665. Theory of Nonlinear Systems** 3 Units
Term Typically Offered: Fall, Spring, Summer
Description: Modern theory of nonlinear systems including phase plane analysis, Lyapunov stability theory, perturbation theory, singular perturbations, describing functions, Lure problem, Popov circle criterion. Applications to closed-loop control systems. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 668. Advanced Robotic Manipulation** 3 Units
Term Typically Offered: Occasionally Offered
Prerequisite(s): ECE 560.
Description: This course presents a broad overview of robotics with focus on manipulators rather than mobile robots. This course will cover the principles of kinematics, dynamics, control, and planning as applied to research robotic manipulation systems. It will discuss serial and parallel robots, multi-fingered robot hands, mobile manipulators, with both motion and force control problems. Topics discussed include: classification of robots, robot kinematics using screw theory, Lagrangian dynamics, nonholonomic constraints, introduction to robot motion planning, computed torque, force, and visual servo control, introduction to grasping and multi-fingered manipulation. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

- ECE 669. System Identification and Estimation** 3 Units
Term Typically Offered: Occasionally Offered
Prerequisite(s): ECE 560.
Description: Introduction to parametric and non-parametric, linear and nonlinear identification methods with applications in many engineering fields, including robots or mechatronic systems, MEMS and NEMS, fluid flow and heat transport phenomena in bio-chemistry. Models are derived from noisy data and quantitatively describing the relationship between system inputs and outputs from data used for prediction, control or optimization. Covers parametric box models such as linear, nonlinear, and recursive autoregressive models, neural networks, nonparametric models such as Empirical Transfer function estimate, and the Kalman Filter. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 682. Advanced Power System Analysis** 3 Units
Prerequisite(s): ECE 582.
Description: Symmetrical components. Unsymmetrical faults. Power system stability. Power system protection. Computer methods. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 687. Platform Engineering Project** 3 Units
Prerequisite(s): ME 530, ME 531 and ECE 532.
Description: Major product development project involving a multidisciplinary team working on design and/or research problems associated with consumer appliance technologies. Concurrent topics on research methodologies, product realization, and project management. A proposal, activity reports and final report are required. Project results are presented for faculty and peer review. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 690. Master of Science Thesis or Paper in Electrical Engineering** 1-6 Units
Prerequisite(s): Graduate or Professional standing.
Description: Performance of an engineering project or research activity under the direction of a faculty member, resulting in a thesis that demonstrates both mastery of the subject matter and a high level of communication skills. A written thesis must be presented and defended orally before a faculty committee for approval and be submitted to a referred conference or referred journal for potential publication. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 692. Master of Science Advanced Level Independent Project** 3-4 Units
Prerequisite(s): Graduate Standing, Approval of the Department Chair.
Description: Students enrolled in this course will engage in an engineering project or research activity and produce a report that demonstrates both mastery of the subject matter and a high level of communication skills. Oral presentation of the report is required. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 693. Independent Study in Electrical & Computer Engineering** 1-6 Units
Prerequisite(s): Approval of a faculty sponsor.
For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 695. Graduate Seminar in Electrical and Computer Engineering 1 Unit**
Term Typically Offered: Spring Only
Prerequisite(s): Graduate or Professional standing.
Description: Students receive career preparation by active participation in technical, career and policy seminars. Topics include current and future technology directions, entrepreneurship, strategic networking, publishing, patenting, reporting and communication, life-long and professional leadership. Content delivered by the instructor, guest speakers and expert webinars. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 696. Advanced Level Oral Presentation** 0 Units
Grading Basis: Pass/Fail
Prerequisite(s): Graduate or Professional Standing and approval of the Department Chair.
Corequisite(s): Enrollment in an approved ECE companion course for the Advanced-Level Project/Research/Communication requirement.
Description: Oral presentation before a faculty committee, of the results of an engineering project or research activity. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 697. Master of Engineering Thesis or Paper in Electrical Engineering** 1-6 Units
Prerequisite(s): ECE 497 and graduate or professional standing.
Description: Performance of a study, design, or investigation under the direction of a faculty member. A written thesis or technical paper must be presented and defended orally before a faculty committee for approval. A paper must be submitted to a referred conference or referred journal for potential publication.
Course Attribute(s): CBL - This course includes Community-Based Learning (CBL). Students will engage in a community experience or project with an external partner in order to enhance understanding and application of academic content. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)
- ECE 700. Dissertation Research in Electrical Engineering** 1-18 Units
Prerequisite(s): Completion of doctoral core program and consent of dissertation director.
Description: Original research activity in an appropriate electrical engineering discipline, under the direction of an Electrical and Computer Engineering graduate faculty member. For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)