# ELECTRICAL AND COMPUTER ENGINEERING

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**Chair**
Jafar Saniie

**Faculty with Research Interests**
For information regarding faculty visit the Department of Electrical and Computer Engineering website.

The Department of Electrical and Computer Engineering offers a Bachelor of Science in Electrical Engineering (B.S.E.E.). The department also offers a Bachelor of Science in Computer Engineering (B.S.CP.E.). Both degree programs are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET).

Minors in areas not listed below require approval from an academic adviser and department chair (for more details, see the Minors section).

- Air Force Aerospace Studies
- Applied Mathematics
- Business
- Energy/Environment/Economics (E3)
- Military Science
- Naval Science
- Premedical Studies
- Telecommunications

The B.S.E.E. curriculum provides a strong foundation in mathematics, physics, chemistry, and computer science during the first two years of study. The fundamentals of circuits, electronics, digital and computer systems, electrodynamics, linear systems, and energy conversion are introduced in the second and third years. In the senior year, students further explore their specific areas of interest and gain in-depth exposure to engineering design through the choice of elective courses.

The B.S.CP.E. curriculum concentrates on the design and application of computer hardware and software systems. During the first three years, the curriculum provides students with a strong foundation in mathematics, physics, chemistry, and computer science, followed by the fundamentals of electrical engineering and computer science that form the basis of computer engineering. During the senior year, advanced courses provide students with depth in selected areas and exposure to the practice of engineering design. Elective courses provide the flexibility to take specialized courses in a number of different areas.

Students with strong interests in both electrical engineering and computer engineering can elect to earn a dual degree, B.S.E.E./B.S.CP.E.

## Degrees Offered

- Bachelor of Science in Computer and Cybersecurity Engineering
- Bachelor of Science in Computer Engineering
- Bachelor of Science in Electrical Engineering
- Bachelor of Science in Electrical Engineering/Bachelor of Science in Computer Engineering (dual degree)

## Co-Terminal Options

The Department of Electrical and Computer Engineering also offers the following co-terminal degrees, which enables a student to simultaneously complete both an undergraduate and graduate degree in as few as five years:

- Bachelor of Science in Biomedical Engineering/Master of Biomedical Imaging and Signals
- Bachelor of Science in Computer Engineering/Master of Computer Science
- Bachelor of Science in Computer Engineering/Master of Science in Computer Science
- Bachelor of Science in Computer Engineering/Master of Science in Computer Engineering
- Bachelor of Science in Computer Engineering/Master of Science in Electrical Engineering
- Bachelor of Science in Electrical Engineering/Master of Science in Computer Engineering
- Bachelor of Science in Electrical Engineering/Master of Science in Electrical Engineering

These co-terminal degrees allow students to gain greater knowledge in specialized areas while, in most cases, completing a smaller number of credit hours with increased scheduling flexibility. For more information, please visit the Department of Electrical and Computer Engineering website (engineering.iit.edu/ece).

## Minors

- Minor in Circuits and Systems
- Minor in Telecommunications

## Course Descriptions

### ECE 100
**Introduction to the Profession I**
Introduces the student to the scope of the engineering profession and its role in society and develops a sense of professionalism in the student. Provides an overview of electrical engineering through a series of hands-on projects and computer exercises. Develops professional communication and teamwork skills.
**Lecture:** 2 **Lab:** 3 **Credits:** 3
**Satisfies:** Communications (C)

### ECE 211
**Circuit Analysis I**
Ohm's Law, Kirchhoff's Laws, and network element voltage-current relations. Application of mesh and nodal analysis to circuits. Dependent sources, operational amplifier circuits, superposition, Thevenin's and Norton's Theorems, maximum power transfer theorem. Transient circuit analysis for RC, RL, and RLC circuits. Introduction to Laplace Transforms. Laboratory experiments include analog and digital circuits; familiarization with test and measurement equipment; combinational digital circuits; familiarization with latches, flip-flops, and shift registers; operational amplifiers; transient effects in first-order and second-order analog circuits; PSpice software applications. Concurrent registration in MATH 252 and ECE 218.
**Prerequisite(s):** MATH 252*, An asterisk (*) designates a course which may be taken concurrently.
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### ECE 213
**Circuit Analysis II**
Sinusoidal excitation and phasors. AC steady-state circuit analysis using phasors. Complex frequency, network functions, pole-zero analysis, frequency response, and resonance. Two-port networks, transformers, mutual inductance, AC steady-state power, RMS values, introduction to three-phase systems and Fourier series. Design-oriented experiments include counters, finite state machines, sequential logic design, impedances in AC steady-state, resonant circuits, two-port networks, and filters. A final project incorporating concepts from analog and digital circuit design will be required. Prerequisites: ECE 211 with a grade C or better.
**Prerequisite(s):** ECE 211 with min. grade of C
**Lecture:** 3 **Lab:** 3 **Credits:** 4
**Satisfies:** Communications (C)

### ECE 216
**Circuit Analysis II**
Sinusoidal excitation and phasors. AC steady-state circuit analysis using phasors. Complex frequency, network functions, pole-zero analysis, frequency response, and resonance. Two-port networks, transformers, mutual inductance, AC steady-state power, RMS values, introduction to three-phase systems and Fourier series. Note: ECE 216 is for non-ECE majors.
**Prerequisite(s):** ECE 211 with min. grade of C
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### ECE 218
**Digital Systems**
Number systems and conversions, binary codes, and Boolean algebra. Switching devices, discrete and integrated digital circuits, analysis and design of combinational logic circuits. Karnaugh maps and minimization techniques. Counters and registers. Analysis and design of synchronous sequential circuits.
**Lecture:** 3 **Lab:** 1 **Credits:** 4
**Satisfies:** Communications (C)

### ECE 222

**Introduction to Cybersecurity Engineering**

Students will receive an introductory overview of major issues related to offensive and defensive cybersecurity. Key topics for this course include ethical hacking tools, penetration testing basics, exploit development, intrusion detection, cyber forensics, and cybersecurity law and regulations. Course projects will provide a hands-on experience using open-source tools and software to support concepts taught during the lecture. Students need to have basic programming skills.
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### ECE 242

**Digital Computers and Computing**

Basic concepts in computer architecture, organization, and programming, including: integer and floating point number representations, memory organization, computer processor operation (the fetch/execute cycle), and computer instruction sets. Programming in machine language and assembly language with an emphasis on practical problems. Brief survey of different computer architectures.
**Prerequisite(s):** (CS 116 and ECE 218) or CS 201
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### ECE 307

**Electrodynamics**

Analysis of circuits using distributed network elements. Response of transmission lines to transient signals. AC steady-state analysis of lossless and lossy lines. The Smith Chart as an analysis and design tool. Impedance matching methods. Vector analysis applied to static and time-varying electric and magnetic fields. Coulomb's Law, electric field intensity, flux density and Gauss's Law. Energy and potential. Biot-Savart and Ampere's Law. Maxwell's equations with applications including uniform-plane wave propagation.
**Prerequisite(s):** ECE 213 and PHYS 221 and MATH 251
**Lecture:** 3 **Lab:** 3 **Credits:** 4

### ECE 308

**Signals and Systems**

Time and frequency domain representation of continuous and discrete time signals. Introduction to sampling and sampling theorem. Time and frequency domain analysis of continuous and discrete linear systems. Fourier series convolution, transfer functions. Fourier transforms, Laplace transforms, and Z-transforms.
**Prerequisite(s):** MATH 252 and MATH 251
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### ECE 311

**Engineering Electronics**

Physics of semiconductor devices. Diode operation and circuit applications. Regulated power supplies. Bipolar and field-effect transistor operating principles. Biasing techniques and stabilization. Linear equivalent circuit analysis of bipolar and field-effect transistor amplifiers. Laboratory experiments reinforce concepts.
**Prerequisite(s):** ECE 213
**Lecture:** 3 **Lab:** 3 **Credits:** 4
**Satisfies:** Communications (C)

### ECE 319

**Fundamentals of Power Engineering**

Principles of electromechanical energy conversion. Fundamentals of the operations of transformers, synchronous machines, induction machines, and fractional horsepower machines. Introduction to power network models and per-unit calculations. Gauss-Seidel load flow. Lossless economic dispatch. Symmetrical three-phase faults. Laboratory considers operation, analysis, and performance of motors and generators. The laboratory experiments also involve use of PC-based interactive graphical software for load flow, economic dispatch, and fault analysis.
**Prerequisite(s):** ECE 213
**Lecture:** 3 **Lab:** 3 **Credits:** 4

### ECE 401

**Communication Electronics**

Radio frequency AM, FM, and PM transmitter and receiver principles. Design of mixers, oscillators, impedance matching networks, filters, phase-locked loops, tuned amplifiers, power amplifiers, and crystal circuits. Nonlinear effects, intermodulation distortion, and noise. Transmitter and receiver design specification.
**Prerequisite(s):** (ECE 307 and ECE 312 and ECE 403*) or Graduate standing, An asterisk (*) designates a course which may be taken concurrently.
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

### ECE 403

**Digital and Data Communication Systems**

Introduction to Amplitude, Phase, and Frequency modulation systems. Multiplexing and Multi-Access Schemes; Spectral design considerations. Sampling theorem. Channel capacity, entropy; Quantization, wave shaping, and Inter-Symbol Interference (ISI), Matched filters, Digital source encoding, Pulse Modulation systems. Design for spectral efficiency and interference control. Probability of error analysis, Analysis and design of digital modulators and detectors.
**Prerequisite(s):** Graduate standing and ECE 308
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

### ECE 405

**Digital and Data Communication Systems with Laboratory**

Introduction to Amplitude, Phase, and Frequency modulation systems. Multiplexing and Multi-Access Schemes; Spectral design considerations. Sampling theorem. Channel capacity, entropy; Quantization, wave shaping, and Inter-Symbol Interference (ISI), Matched filters, Digital source encoding, Pulse Modulation systems. Design for spectral efficiency and interference control. Probability of error analysis, Analysis and design of digital modulators and detectors.
**Prerequisite(s):** Graduate standing and ECE 308
**Lecture:** 3 **Lab:** 3 **Credits:** 4
**Satisfies:** ECE Professional Elective (P)

### ECE 406
**Wireless Communications Systems**
The course addresses the fundamentals of wireless communications and provides an overview of existing and emerging wireless communications networks. It covers radio propagation and fading models, fundamentals of cellular communications, multiple access technologies, and various wireless networks including past and future generation networks. Simulation of wireless systems under different channel environments will be an integral part of this course.
**Prerequisite(s):** ECE 403 or Graduate standing
**Lecture:** 3 **Lab:** 3 **Credits:** 3

### ECE 407
**Introduction to Computer Networks with Laboratory**
Emphasis on the physical, data link, and medium access layers of the OSI architecture. Different general techniques for networking tasks, such as error control, flow control, multiplexing, switching, routing, signaling, congestion control, traffic control, scheduling will be covered along with their experimentation and implementation in a laboratory. Credit given for ECE 407 or ECE 408, not both.
**Lecture:** 3 **Lab:** 3 **Credits:** 4
**Satisfies:** ECE Professional Elective (P)

### ECE 408
**Introduction to Computer Networks**
Emphasis on the physical, data link and medium access layers of the OSI architecture. Different general techniques for networking tasks, such as error control, flow control, multiplexing, switching, routing, signaling, congestion control, traffic control, scheduling will be covered. Credit given for ECE 407 or ECE 408, not both.
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

### ECE 411
**Power Electronics**
Power electronic circuits and switching devices such as power transistors, MOSFET's, SCR's, GTO's, IGBT's and UJT's are studied. Their applications in AC/DC DC/DC, DC/AC and AC/AC converters as well as switching power supplies are explained. Simulation mini-projects and lab experiments emphasize power electronic circuit analysis, design and control.
**Prerequisite(s):** ECE 311 or Graduate standing
**Lecture:** 3 **Lab:** 3 **Credits:** 4
**Satisfies:** ECE Professional Elective (P)

### ECE 412
**Hybrid Electric Vehicle Drives**
Fundamentals of electric motor drives are studied. Applications of semiconductor switching circuits to adjustable speed drives, robotic, and traction are explored. Selection of motor drives, calculating the ratings, speed control, position control, starting, and braking are also covered. Simulation mini-projects and lab experiments are based on the lectures given.
**Prerequisite(s):** (ECE 311 and ECE 319) or Graduate standing
**Lecture:** 3 **Lab:** 3 **Credits:** 4
**Satisfies:** ECE Professional Elective (P)

### ECE 417
**Power Distribution Engineering**
This is an introduction into power distribution systems from the utility engineering perspective. The course looks at electrical service from the distribution substation to the supply line feeding a customer. The course studies the nature of electrical loads, voltage characteristics and distribution equipment requirements. The fundamentals of distribution protection are reviewed including fast/relay coordination. Finally, power quality and reliability issues are addressed.
**Prerequisite(s):** ECE 319 or Graduate standing
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

### ECE 418
**Power System Analysis**
Transmission systems analysis and design. Large scale network analysis using Newton-Raphson load flow. Unsymmetrical short-circuit studies. Detailed consideration of the swing equation and the equal-area criterion for power system stability studies. Credit will be given for ECE 418 or ECE 419, but not for both.
**Prerequisite(s):** ECE 319 or Graduate standing
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

### ECE 419
**Power Systems Analysis with Laboratory**
Transmission systems analysis and design. Large scale network analysis using Newton-Raphson load flow. Unsymmetrical short-circuit studies. Detailed consideration of the swing equation and the equal-area criterion for power system stability studies. Use of commercial power system analysis tool to enhance understanding in the laboratory.
**Prerequisite(s):** ECE 319 or Graduate standing
**Lecture:** 3 **Lab:** 3 **Credits:** 4
**Satisfies:** ECE Professional Elective (P)

### ECE 420
**Analytical Methods for Power System Economics and Cybersecurity**
Analytical Methods for the Economic operation of power systems with consideration of transmission losses. Analytical methods for the optimal scheduling of power generation, including real power and reactive power. Analytical methods for the estimation of power system state. Analytical methods for the modeling of smart grid cybersecurity.
**Prerequisite(s):** ECE 319 or Graduate standing
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

### ECE 421
**Microwave Circuits and Systems**
Maxwell's equations, waves in free space, metallic and dielectric waveguides, microstrips, microwave cavity resonators and components, ultra-high frequency generation and amplification. Analysis and design of microwave circuits and systems. Credit will be given for either ECE 421 or ECE 423, but not for both.
**Prerequisite(s):** ECE 307 or Graduate standing
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

**ECE 423**

**Microwave Circuits and Systems with Laboratory**

Maxwell's equations, waves in free space, metallic and dielectric waveguides, microstrips, microwave cavity resonators and components, ultra-high frequency generation and amplification. Analysis and design of microwave circuits and systems. Credit will be given for either ECE 421 or ECE 423, but not for both.

**Prerequisite(s):** ECE 307 or Graduate standing

**Lecture:** 3 **Lab:** 3 **Credits:** 4

**Satisfies:** ECE Professional Elective (P)

**ECE 425**

**Analysis and Design of Integrated Circuits**

Contemporary analog circuit analysis and design techniques. Bipolar, CMOS and BICMOS IC fabrication technologies, IC Devices and Modeling, Analog ICs including multiple-transistor amplifiers, biasing circuits, active loads, reference circuits, output buffers; their frequency response, stability and feedback consideration.

**Prerequisite(s):** ECE 311

**Lecture:** 3 **Lab:** 0 **Credits:** 3

**Satisfies:** ECE Professional Elective (P)

**ECE 429**

**Introduction to VLSI Design**

Processing, fabrication, and design of Very Large Scale Integration (VLSI) circuits. MOS transistor theory, VLSI processing, circuit layout, layout design rules, layout analysis, and performance estimation. The use of computer aided design (CAD) tools for layout design, system design in VLSI, and application-specific integrated circuits (ASICs). In the laboratory, students create, analyze, and simulate a number of circuit layouts as design projects, culminating in a term design project.

**Prerequisite(s):** (ECE 218 and ECE 311) or Graduate standing

**Lecture:** 3 **Lab:** 3 **Credits:** 4

**Satisfies:** ECE Professional Elective (P)

**ECE 430**

**Fundamentals of Semiconductor Devices**

The goals of this course are to give the student an understanding of the physical and operational principles behind important electronic devices such as transistors and solar cells. Semiconductor electron and hole concentrations, carrier transport, and carrier generation and recombination are discussed. P-N junction operation and its application to diodes, solar cells, and LEDs are developed. The field-effect transistor (FET) and bipolar junction transistor (BJT) are then discussed and their terminal operation developed. Application of transistors to bipolar and CMOS analog and digital circuits is introduced.

**Prerequisite(s):** ECE 311

**Lecture:** 3 **Lab:** 0 **Credits:** 3

**Satisfies:** ECE Professional Elective (P)

**ECE 436**

**Digital Signal Processing I with Laboratory**

Discrete-time system analysis, discrete convolution and correlation, Z-transforms. Realization and frequency response of discrete-time systems, properties of analog filters, IIR filter design, FIR filter design. Discrete Fourier Transforms. Applications of digital signal processing. Credit will be given for either ECE 436 or ECE 437, but not for both.

**Prerequisite(s):** ECE 308 or Graduate standing or BME 330

**Lecture:** 3 **Lab:** 3 **Credits:** 4

**Satisfies:** ECE Professional Elective (P)

**ECE 437**

**Digital Signal Processing I**

Discrete-time system analysis, discrete convolution and correlation, Z-transforms. Realization and frequency response of discrete-time systems, properties of analog filters, IIR filter design, FIR filter design. Discrete Fourier Transforms. Applications of digital signal processing. Credit will be given for either ECE 436 or ECE 437, but not for both.

**Prerequisite(s):** ECE 308 or Graduate standing or BME 330

**Lecture:** 3 **Lab:** 0 **Credits:** 3

**Satisfies:** ECE Professional Elective (P)

**ECE 438**

**Control Systems**

Signal-flow graphs and block diagrams. Types of feedback control. Steady-state tracking error. Stability and Routh Hurwitz criterion. Transient response and time domain design via root locus methods. Frequency domain analysis and design using Bode and Nyquist methods. Introduction to state variable descriptions.

**Prerequisite(s):** ECE 308 or BME 330 or Graduate standing

**Lecture:** 3 **Lab:** 0 **Credits:** 3

**Satisfies:** ECE Professional Elective (P)

**ECE 441**

**Smart and Connected Embedded System Design**

This is a culminating major design experience course that involves smart and connected system applications including Internet of Things, healthcare system, artificial intelligence and machine vision, wireless sensor network, smart security system, smart city, smart power grid, smart power electronic devices, smart transportation, factory automation, agriculture automation, and home automation. Smart and connected system entails human machine interface, embedded computing, interrupt/exception handling, fault detection and recovery, standard and special peripheral interfacing to sensors and actuators, hardware and software codesign for data acquisition, encryption/decryption for secure system, information processing, data storage, and network communication protocols. The design project incorporates engineering standards and multiple constraints, building on knowledge and skills acquired from 100 to 300 level ECE coursework.

**Lecture:** 3 **Lab:** 3 **Credits:** 4

**Satisfies:** ECE Professional Elective (P)

**ECE 442**
**Internet of Things and Cyber Physical Systems**
To introduce students to the fundamentals of Internet of Things (IoT) and embedded computing. This course covers IoT applications, Wireless protocols, Wearable sensors, Home environment sensors, Behavior detection sensors, Data fusion, processing and analysis, Data communications, Architectural design issues of IoT layers, Security and privacy issues in IoT.
**Prerequisite(s):** ECE 242 or Graduate standing
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

**ECE 443**
**Introduction to Computer Cyber Security**
This course gives students a clear understanding of computer and cyber security as threats and defense mechanisms backed by mathematical and algorithmic guarantees. Key topics covered include introductory number theory and complexity theory, cryptography and applications, system security, digital forensics, software and hardware security, and side-channel attacks. Course projects will provide hand-on experiences on languages, libraries, and tools supporting state-of-theart cryptography applications. Students registering for ECE 518 are required to complete additional projects in advanced areas.
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

**ECE 444**
**Computer Network Security**
This course studies computer network security by covering topics such as fundamental cryptographic algorithms; protocol design and analysis for secure communications over Internet; efficient key management infrastructure; strong password protection; attack and security models; practical security protocols in application layer, transport layer, network layer, and link layer. Students registering for ECE 543 are required to complete additional projects in advanced areas.
**Prerequisite(s):** ECE 407 or ECE 408
**Lecture:** 3 **Lab:** 0 **Credits:** 3

**ECE 446**
**Advanced Logic Design**
Design and implementation of complex digital systems under practical design constraints. Timing and electrical considerations in combinational and sequential logic design. Digital system design using Algorithmic State Machine (ASM) diagrams. Design with modern logic families and programmable logic. Design-oriented laboratory stressing the use of programmable logic devices.
**Prerequisite(s):** (ECE 218 and ECE 311) or Graduate standing
**Lecture:** 3 **Lab:** 3 **Credits:** 4
**Satisfies:** ECE Professional Elective (P)

**ECE 447**
**Artificial Intelligence and Edge Computing**
This course introduces methods in designing contemporary smart systems utilizing artificial intelligence, machine vision, and their applications. Topics include linear regression, logistic regression, multilayer neural networks, supervised/unsupervised learning, convolutional networks, and recurrent neural networks. This course also covers topics in deep learning algorithms and artificial intelligence structures optimized for low power embedded computing platforms (Edge Artificial Intelligence) with applications in machine vision, robotics, internet of things, smart grids and autonomous systems.
**Lecture:** 3 **Lab:** 0 **Credits:** 3

**ECE 448**
**Application Software Design**
The course provides introduction to languages and environments for application software development utilizing Software as a Service (SaaS) for electrical and computer engineers. Languages addressed include Java, Python, SQL, and JavaScript. Key topics covered include systems development life cycle, client-server architectures, database integration, RESTful service, and data visualization. Programming projects will include the development of a data-rich web application with server back-end that connects mobile devices and Internet of Things using Agile software engineering practices.
**Prerequisite(s):** ECE 242
**Lecture:** 3 **Lab:** 0 **Credits:** 3

**ECE 449**
**Object-Oriented Programming and Machine Learning**
This course gives students a clear understanding of the fundamental concepts of object-oriented design/programming (OOD/OOP). Languages addressed include C++ and Python. Key topics covered include introduction to machine and deep learning, software development life cycle, core language and standard library of C++ and Python, class design and design patterns, OpenMP and CUDA platforms. Students will design a complex learning application using these concepts and Agile software engineering practices.
**Prerequisite(s):** ECE 242 with min. grade of C
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

**ECE 460**
**Introduction to Signals and Systems for Advanced Studies**
This course provides an introduction to Signals and Systems and illustrates the concepts using representative examples and applications. Basic concepts, including continuous-time and discrete-time signals and their properties, are covered. Properties and applications of continuous-time and discrete-time convolution, Fourier series, Fourier transform, Discrete Fourier transform, Laplace transform, and Z-transform are also covered. A significant number of examples are used to illustrate the basic concepts. This course is intended to provide a strong foundation for students who are entering graduate programs in Electrical and Computer Engineering (ECE) without an undergraduate degree in ECE. This course is not intended for credits as part of the degree programs at Illinois Tech.
**Lecture:** 3 **Lab:** 0 **Credits:** 3

**ECE 461**

**Introduction to Probability and Random Variables for Advanced Studies**

This course provides introduction to Probability and Random Variables and illustrates the concepts using representative examples and applications. Basic concepts including probability axioms, random and repeated experiments, conditional probability, discrete, continuous, and mixed random variables, moments and characteristic function, and a function of multiple random variables are covered. Significant number of examples are used to illustrate the basic concepts. The intent of this course is to provide strong foundation for students who are entering the graduate programs in Electrical and Computer Engineering (ECE) without an undergraduate degree in ECE. This course is not intended for credits as part of the degree programs at Illinois Tech.
**Lecture:** 3 **Lab:** 0 **Credits:** 3

**ECE 473**

**Cloud Computing and Cloud Native Systems**

This course introduces students to cloud native systems that build on top of the cloud computing architecture to provide scalable services in dynamic environments. Key topics covered include virtualization and containerization, distributed database systems, communication mechanisms, batch and stream processing, resource management, consensus, security, and system design techniques for scalability, resilience, manageability, and observability. Course projects will provide hand-on experiences on state-of-the-art languages, libraries, and tools.
**Prerequisite(s):** ECE 242
**Lecture:** 3 **Lab:** 0 **Credits:** 3

**ECE 481**

**Image Processing**

Mathematical foundations of image processing, including two-dimensional discrete Fourier transforms, circulant and block-circulant matrices. Digital representation of images and basic color theory. Fundamentals and applications of image enhancement, restoration, reconstruction, compression, and recognition.
**Prerequisite(s):** (ECE 308 and MATH 374*) or Graduate standing, An asterisk (*) designates a course which may be taken concurrently.
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

**ECE 485**

**Computer Organization and Design**

This course provides the students with understanding of the fundamental concepts of computer architecture, organization, and design. It focuses on relationship between hardware and software and its influence on the instruction set and the underlying Central Processing Unit (CPU). The structural design of the CPU in terms of datapath and control unit is introduced. The technique of pipelining and hazard management are studied. Advanced topics include instruction level parallelism, memory hierarchy and cache operations, virtual memory, parallel processing, multiprocessors and hardware security. The end to end design of a typical computer system in terms of the major entities including CPU, cache, memory, disk, I/O, and bus with respect to cost/performance trade-offs is also covered. Differentiation between ECE 485 and ECE 585 is provided via use of projects / case studies at differing levels. (3-0-3) Undergraduate students can only be admitted to ECE 485 Graduate students can only be admitted to ECE 585.
**Prerequisite(s):** (ECE 218 and ECE 242) or Graduate standing
**Lecture:** 3 **Lab:** 0 **Credits:** 3
**Satisfies:** ECE Professional Elective (P)

**ECE 491**

**Undergraduate Research**

Independent work on a research project supervised by a faculty member of the department. Prerequisite: Consents of academic advisor and instructor.
**Credit:** Variable
**Satisfies:** ECE Professional Elective (P)

**ECE 494**

**Undergraduate Projects**

Students undertake a project under the guidance of an ECE department faculty member. (1-4 variable) Prerequisite: Approval of the ECE instructor and academic advisor.
**Credit:** Variable
**Satisfies:** ECE Professional Elective (P)

**ECE 497**

**Special Problems**

Design, development, analysis of advanced systems, circuits, or problems as defined by a faculty member of the department. Prerequisite: Consents of academic advisor and instructor.
**Credit:** Variable
**Satisfies:** ECE Professional Elective (P)