

# EE-Electrical & Computer Engineering

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## EE 512. Practical Computer Vision. 3 Hours.

This course covers fundamentals and application of image analysis. Topics include: image pre-processing, detection, segmentation, classification and recognition, visual tracking, and deep learning.

## EE 518. Wireless Communications. 3 Hours.

This course covers the principles and current applications of wireless technology. Topics include propagation models, modulation, multiple access, and channel and signal coding. Applications of wireless for cellular and Internet of Things (IoT) will also be covered.

## EE 523. Digital Signal Processing. 3 Hours.

This course covers the theory and practice of using computers to process and analyze signals. The topics include: digital filter analysis and design; Fast Fourier Transform (FFT) algorithms; applications of digital signal processing in engineering problems such as data acquisition and control.

## EE 526. Control Systems. 3 Hours.

This course covers modeling and control of mechanisms or circuits to satisfy stability and performance criteria. Topics include: theory of linear feedback control systems using complex frequency techniques, block diagram manipulation, performance measures, stability, analysis and design using root locus, and Z-transform methods.

## EE 527. Controls and Automation. 3 Hours.

This course covers power control devices and applications, relay logic and translation to other forms, programmable logic controllers (PLCs), proportional-integral-derivative (PID) and other methods for process control, modern laboratory instrumentation, and human-machine interface (HMI) software.

## EE 531. Analog Integrated Electronics. 4 Hours.

This course covers advanced analysis and design using op-amps, differential amplifier, half-circuit analysis, error analysis and compensation. Applications include signal conditioning for instrumentation, instrumentation amplifiers, nonlinear and computational circuits, analog filter design, voltage regulator design, and oscillators, circuit configurations for A-to-D and D-to-A conversion methods. Laboratory exercises emphasize design techniques for projects in areas such as Internet-of-Things (IoT).

## EE 532. Introduction to Computer Networking. 3 Hours.

This course covers the fundamentals of modern computer networks including current applications such as Internet of Things (IoT). Topics include: hardware and software level network protocols, network architecture and topology including WANs and LANs, client-server relationships, distributed computing, data transfer, security, virtualization of hardware, multi-tier network configuration examples, and certifications will be addressed.

**Prerequisites:** EE 134 [Min Grade: C] and EE 210 [Min Grade: C]

## EE 533. Engineering Software Solutions. 3 Hours.

This course covers the fundamentals of software design, architecture, and implementation for future software engineers. Topics include: customer-focused requirements gathering, project planning, team tools, architectural patterns, environment and component selection, quality assurance, sustainability, and versioning. Various development methodologies are discussed with a project demonstrating at least one release cycle.

## EE 534. Power and Radio-Frequency Semiconductor Electronics. 3 Hours.

This course covers the fundamentals of power electronics such as principles of static power conversions, basic power converter architectures, power semiconductor switches, steady-state equivalent circuit modeling, DC transformer model, basic AC equivalent circuit modeling, linearization and perturbation. Pulse width modulation and controller design, circuit design considerations, and applications of power electronics. The course project emphasizes computer-aided analysis and design of power electronic circuits.

## EE 537. Introduction to Embedded Systems. 3 Hours.

This course provides an applied introduction to the design of embedded systems, including hardware and software aspects. Topics include: various embedded hardware platforms, interfacing industrial bus systems, sensors, actuators, low-power wireless communication, and application of Internet of Things (IoT).

## EE 538. Computer Architecture. 3 Hours.

Advanced microprocessor topics including cache design, pipelining, superscalar architecture, design of control units, microcoding, and parallel processors. Comparison of advanced, contemporary microprocessors from Intel and IBM. Basic knowledge in microprocessors is recommended.

## EE 543. Medical Imaging Processing. 3 Hours.

A lab-based introduction to processing analysis and display techniques for medical imaging.

## EE 544. Real-Time Process & Protocols. 3 Hours.

This course covers hands-on laboratory topics in real-time computer systems, such as algorithms, state-machine implementations, communication protocols, instrumentation, and hardware interfaces.

## EE 547. Internet/Intranet Application Development. 3 Hours.

This course covers development of software models and applications using Internet/Intranet technologies. Topics include: web client-server relationships, multi-tier design models, scripting and validation, basic TCP/IP networking, separation of concerns, markup and data description languages. Projects will allow the opportunity for the use of a range of tools and development platforms.

**Prerequisites:** EE 233 [Min Grade: C]

## EE 548. Software Engineering Projects. 3 Hours.

This course covers practical applications of software engineering including development of applications for Internet of Things (IoT). Topics include: requirements gathering, design matrices, environment selection, relevant architectural patterns, networking basics, databases, service endpoints, embedded systems selection and security. Projects with a software emphasis will be utilized to demonstrate principles of IoT applications.

**Prerequisites:** EE 333 [Min Grade: C]

## EE 552. Digital Systems Design. 3 Hours.

This course covers the design of customized complex digital systems using Field Programmable Gate Array (FPGA) based platforms, using modern design tools for simulation, synthesis, and implementation. Topics include hardware design and development languages such as Verilog or VHDL.

## EE 558. Medical Instrumentation. 3 Hours.

This course covers the fundamental operating principles, applications, safety, and design of electronic instrumentation used in the measurement of physiological parameters.

**EE 561. Machinery II. 3 Hours.**

Physical principles of DC machines. Mathematical analysis of generator designs using equivalent circuits and magnetization curves. Calculation of motor speed, torque, power, efficiency, and starting requirements. Solid-state speed control systems.

**EE 567. Brain Machine Interface. 3 Hours.**

This course explores the brain-machine interfaces, particularly the technologies that directly stimulate and/or record neural activity. This course is divided into three major components: 1) neuroscience and electrode interfaces, 2) brain recording and stimulating front-end circuits, and 3) circuit modeling, simulating, and optimization.

**EE 571. Power Systems I. 3 Hours.**

Components of power systems. Performance of modern interconnected power system under normal and abnormal conditions. Calculation of inductive and capacitive reactances of three-phase transmission lines in steady state. EE 351 (Electronics) or equivalent is a prerequisite for this course.

**EE 572. Power Systems II. 3 Hours.**

Modeling of generators, transformers, and transmission lines for system studies. Introduction to symmetrical components. Calculation of short-circuit currents due to balanced and unbalanced faults. Determination of interrupting ratings of circuit breakers. Transient stability of power systems. Derivation of swing equation and solution by numerical method. Equal area criterion. Power system design project required.

**EE 573. Protective Relaying of Power Systems. 3 Hours.**

Operating principles of protective relays. Protection of transmission lines, generators, motors, transformers, and buses.

**EE 585. Engineering Operations. 3 Hours.**

This course covers the principles and standard of engineering design from ideation to final design. Topics include: product development process, problem definition and need identification, embodiment and detail design, design for specific criterion, modeling and cost evaluation. Emphasis is placed on ethics and civil responsibilities in design including environmental, social, liable, sustainability and reliability through the lens of engineering design.

**EE 590. Special Topics in Electrical and Computer Engineering. 1-3 Hour.**

Special Topic in Electrical or Computer Engineering.

**EE 591. Individual Study in Electrical and Computer Engineering. 1-6 Hour.**

Individual Study in Electrical Engineering.

**EE 601. Electrical and Computer Engineering Seminar. 1-3 Hour.**

This course consists of research presentations and colloquia delivered by faculty, research assistants, and invited guests in various state-of-the-art and popular topics related to Electrical and Computer Engineering. Required of all full-time Electrical and Computer Engineering graduate students.

**EE 610. Technical Communication for Engineers. 3 Hours.**

A workshop-oriented course providing students with the opportunity to produce technical memoranda, a proposal, and a conference and/or refereed journal paper and to make oral presentations related to these work products utilizing appropriate software presentation aids.

**EE 616. Design of CMOS Analog Integrated Circuits. 3 Hours.**

This course will cover basic building blocks of CMOS analog VLSI design, MOSFET theory, short channel device and nonlinear effects, current mirrors, current-reference generator, operational trans conductance amplifier, switched capacitor architecture, analog-to-digital converter and digital-to-analog converter. Students will be required to develop a computer aided design, simulation, and chip layout of an analog integrated circuit design project. Fundamental knowledge of electronics is required.

**EE 621. Random Variables and Processes. 3 Hours.**

Theory underlying analysis and design of communication, stochastic control, data gathering, and data analysis systems.

**Prerequisites:** EE 421 [Min Grade: C]

**EE 622. Advanced Communication Theory. 3 Hours.**

Analysis of performance of analog modulation techniques in presence of noise.

**Prerequisites:** EE 621 [Min Grade: C]

**EE 623. Computer Vision. 3 Hours.**

Advanced topics in computer vision: image segmentation, registration, and visual tracking; Applications of deep learning to image analysis.

**EE 624. Digital Communications. 3 Hours.**

Design and analysis of digital communications modulation techniques and systems and their performance in the presence of noise.

**Prerequisites:** EE 622 [Min Grade: C]

**EE 625. Information Theory and Coding. 3 Hours.**

Channel models and block codes, block code ensemble performance analysis, convolutional codes and ensemble performance, sequential decoding of convolutional codes.

**Prerequisites:** EE 621 [Min Grade: C]

**EE 626. Digital Image Processing. 3 Hours.**

Digital imaging processing fundamentals, image transformations, enhancement, restoration, compression, and representation. Introduction to image segmentation.

**EE 627. Wireless Communications. 3 Hours.**

Wireless communication system topics such as propagation, modulation techniques, multiple access techniques, channel coding, speech and video coding, and wireless computer networks.

**EE 632. Introduction to Computer Networking. 3 Hours.**

Computer networking fundamentals. Layered network model and correspondence to real systems. Discussion of Ethernet, Token Ring, TCP/IP, LAN, and other protocols. Exploration of the Internet and similar systems. Network application models. Simulation of networks.

**EE 633. Experiments in Computer Networking. 3 Hours.**

Detailed exploration of particular issues in network protocols and network application models. Development of series of programs to explore the details of network protocols and network application models.

**EE 634. Introduction to Neural Networks. 3 Hours.**

Artificial neural network topologies and training algorithms with an emphasis on back propagation. Deep learning with Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), applications and limitations of neural networks, and designing networks specific uses.

**EE 636. Advanced Digital Design. 3 Hours.**

This course covers to design with Complex Programmable Logic Devices (CPLDs) and Field Programmable Gate Arrays (FPGAs). Topics include design, simulation, and testing of digital systems using a hardware description language and FPGA/CPLD development boards with programmable logic devices.

**EE 637. Design of Modern Computer with Digital Integrated Circuits. 3 Hours.**

This course covers the design of advanced digital circuits with VLSI components. Topics include synthesis, design, simulation, and testing of advanced digital circuits using a hardware description language and FPGA/CPLD development boards with programmable logic devices. Design examples: switching networks, graphics engine, DSP, Internet of Things (IoT) controller, and programmable logic controller (PLC).

**EE 638. Neural Time Series Data Analysis. 3 Hours.**

This course covers theory and practice of analyzing brain signals. Students will learn about conceptual, mathematical and implementational (via MATLAB programming) aspects of time-, frequency- and synchronization-based analyses of magnetoencephalography (MEG), electroencephalography (EEG), and local field potential (LFP) recordings from humans and nonhuman animals.

**EE 639. Embedded Systems. 3 Hours.**

This course covers both hardware and software trends in advanced embedded system design, including artificial intelligence (AI) and optimized hardware platforms for machine learning (ML). The fundamental algorithms of AI and ML are discussed. Various process acceleration techniques for improving the computational efficiency of ML kernels are implemented on FPGA/CPLD development boards and FPGA/CPLD chips.

**EE 640. Object-Oriented Design. 3 Hours.**

This course provides in-depth coverage of object-oriented design principles and methodologies. Topics include object-oriented design frameworks, use-cases, class-responsibility-collaboration (RCR), design patterns, and software reuse. Knowledge of an object-oriented language is recommended.

**EE 641. Modern Control Theory. 3 Hours.**

This course covers state variable models for analog time and discrete time systems, state feedback and pole placement, and state estimation. Knowledge of basic control systems is recommended.

**EE 642. Intelligent Systems. 3 Hours.**

This course covers organization and characteristics of intelligent systems, optimization, evolutionary algorithms, neural networks, fuzzy logic algorithms, and intelligent control.

**EE 643. Numerical Methods in Engineering. 3 Hours.**

This course covers theory and practice of numerical methods for a broad spectrum of engineering applications and data analyses. Using numerical calculus, linear algebra, and optimization students will be exposed to modern topics such as convolutional neural networks, compressed sensing, eigenfaces, stability, principal component analysis, k-means clustering, image segmentation with active contours, detection of a signal in noise, and function fitting. This course develops abstract thinking by showing generalizations of commonly used terms such as length, area, volume, but also provides hands-on practical experience with programming numerical analysis algorithms.

**EE 650. Software Engineering. 3 Hours.**

This course covers the engineering approach to developing software solutions to real-world problems. Topics include overview of Software Engineering, requirements elicitation, design, implementation, and an overview of software development methods.

**EE 651. Software Engineering Large Systems - I. 3 Hours.**

This course covers advanced integrated software systems development and prescriptive software systems development methods are covered with an in-depth exploration through team projects using current software development methods.

**EE 653. Electronic Power Switching Circuits. 3 Hours.**

This course covers software development in enterprise environments using Dev-Ops practices such as continuous integration and delivery.

**EE 654. Mobile Computing. 3 Hours.**

This course covers the fundamentals and advanced concepts in mobile computing. Develop user interface, application logic, and back-end services, using advanced integrated development environments. Individual and team projects. Programming required.

**EE 655. Cloud Computing. 3 Hours.**

This course covers fundamental and advanced concepts in cloud computing, including evaluation of current market offerings. Students will also design and implement systems integrating multiple cloud computing services.

**EE 656. Introduction to Big Data Analytics. 3 Hours.**

This course covers an introduction to the field of big data analytics, including technologies, challenges, architecture, and hypothesis testing.

**EE 658. Machine Learning in Engineering. 3 Hours.**

This course covers techniques for developing solutions to complex problems in different engineering domains without having to explicitly program the computers. Topics include supervised and unsupervised learning, classification and regression, support vector machines (SVM), boosting, and artificial neural networks.

**EE 667. Advanced Brain Machine Interface. 3 Hours.**

This course consists of four major parts: 1) neuroscience and electrode interfaces, 2) front-end circuit design, 3) power/data links and graphical user interface, and 4) circuit, wireless link, and safety simulating software-learning parts.

**EE 672. Power System Overvoltages. 3 Hours.**

Events causing overvoltages, and protection of system.

**EE 682. Electromagnetic Field Theory I. 3 Hours.**

This course covers the modeling of materials and environments through simulation of electromagnetic fields. It includes a wide variety of applications, including biomedical and Internet of Things (IoT). Topics include boundary-value problems and scattering.

**EE 690. Special Topics in (Area). 1-6 Hour.**

Special topics selected by faculty for master's students.

**EE 691. Individual Study in (Area). 1-6 Hour.**

Individual study selected by faculty for master's students.

**EE 697. Graduate Project. 3 Hours.**

Graduate project for Plan II Masters students.

**EE 698. Non-Thesis Research. 1-12 Hour.**

Individual research in selected area by faculty for master's students.

**EE 699. Thesis Research. 1-12 Hour.**

Thesis research.

**Prerequisites:** GAC M

**EE 701. Electr & Comptr EGR Sem. 1-3 Hour.**

Consists of research presentations and colloquia delivered by faculty, research assistants, and invited guests in various state-of-the-art and popular topics related to Electrical and Computer Engineering. Maximum of 3.0 credit hours applicable toward M.S.E.E. degree.

**EE 716. Design of CMOS Analog Integrated Circuits. 3 Hours.**

This course will cover basic building blocks of CMOS analog VLSI design, MOSFET theory, short channel device and nonlinear effects, current mirrors, current-reference generator, operational trans conductance amplifier, switched capacitor architecture, analog-to-digital converter and digital-to-analog converter. Students will be required to develop a computer aided design, simulation and chip layout of an analog integrated circuit design project. Fundamental knowledge in electronics is required.

**EE 723. Computer Vision. 3 Hours.**

Advanced topics in computer vision: Image segmentation, registration, and visual tracking. Applications of deep learning to image analysis.

**EE 724. Digital Communications. 3 Hours.**

Design and analysis of digital communications modulation techniques and systems and their performance in the presence of noise.

**Prerequisites:** EE 622 [Min Grade: C]

**EE 725. Information Theory and Coding. 3 Hours.**

Channel models and block codes, block code ensemble performance analysis, convolutional codes and ensemble performance, sequential decoding of convolutional codes.

**Prerequisites:** EE 622 [Min Grade: C]

**EE 726. Digital Image Processing. 3 Hours.**

Digital image processing fundamentals: image transformations, enhancement, restoration, compression, and representation. Introduction to image segmentation.

**EE 727. Wireless Communications. 3 Hours.**

Wireless communication system topics such as propagation, modulation techniques, multiple access techniques, channel coding, speech and video coding, and wireless computer networks.

**EE 729. Telecommunications II. 3 Hours.**

Advanced Topics.

**EE 732. Introduction to Computer Networking. 3 Hours.**

Computer networking fundamentals. Layered network model and correspondence to real systems. Discussion of Ethernet, Token Ring, TCP/IP, LAN, and other protocols. Exploration of the Internet and similar systems. Network application models. Simulation of networks.

**EE 733. Experiments in Computer Networking. 3 Hours.**

Detailed exploration of particular issues in network protocols and network application models. Development of series of programs to explore the details of network protocols and network application models.

**EE 734. Introduction to Neural Networks. 3 Hours.**

Artificial neural network topologies and training algorithms with an emphasis on back propagation. Deep learning with Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Applications and limitations of neural networks, and designing networks for specific uses.

**EE 737. Design of Modern Computers with Digital Integrated Circuits. 3 Hours.**

This course covers the design of advanced digital circuits with VLSI components. Topics include synthesis, design, simulation, and testing of advanced digital circuits using a hardware description language and FPGA/CPLD development boards with programmable logic devices. Design examples: switching networks, graphics engine, DSP, Internet of Things (IoT) controller, and programmable logic controller (PLC).

**EE 738. Neural Time Series Data Analysis. 3 Hours.**

This course covers theory and practice of analyzing brain signals. Students will learn about conceptual, mathematical and implementational (via MATLAB programming) aspects of time-, frequency- and synchronization-based analyses of magnetoencephalography (MEG), electroencephalography (EEG), and local field potential (LFP) recordings from humans and nonhuman animals.

**EE 740. Object-Oriented Design. 3 Hours.**

This course provides in-depth coverage of object-oriented design principles and methodologies. Topics include: object-oriented design frameworks, use-cases, class-responsibility-collaboration (CRC), design patterns, and software reuse. Knowledge of an object-oriented language is recommended.

**EE 742. Intelligent Systems. 3 Hours.**

This course covers organization and characteristics of intelligent systems, optimization, evolutionary algorithms, neural networks, fuzzy logic algorithms, and intelligent control.

**EE 743. Numerical Methods in Engineering. 3 Hours.**

This course covers theory and practice of numerical methods for a broad spectrum of engineering applications and data analyses. Using numerical calculus, linear algebra, and optimization students will be exposed to modern topics such as convolutional neural networks, compressed sensing, eigenfaces, stability, principal component analysis, k-means clustering, image segmentation with active contours, detection of a signal in noise, and function fitting. This course develops abstract thinking by showing generalizations of commonly used terms such as length, area, volume, but also provides hands-on practical experience with programming numerical analysis algorithms.

**EE 746. Batch Control. 3 Hours.**

Theory, analysis, and synthesis of batch processing control systems.

**EE 747. Distributed Control Systems. 3 Hours.**

Application of distributed control to process, integration, and operator interfaces.

**EE 748. Process Analyzers. 3 Hours.**

Automated analytical techniques for identifying chemical process streams.

**EE 750. Software Engineering. 3 Hours.**

This course covers the engineering approach to developing software solutions to real-world problems. Topics include an overview of Software Engineering, requirements elicitation, design, implementation, and an overview of software development methods.

**EE 751. Software Engineering Large Systems - I. 3 Hours.**

This course covers advanced integrated software systems development methods. Adaptive and prescriptive software systems development methods are covered with an in-depth exploration through team projects using current software development methods.

**EE 752. Software Engineering Large Systems - II. 3 Hours.**

This course covers software development in enterprise environments using Dev-Ops practices such as continuous integration and delivery.

**EE 754. Mobile Computing. 3 Hours.**

This course covers the fundamentals and advanced concepts. Develop user interface, application logic, and backend services, using advanced integrated development environments. Individual and team projects. Programming required.

**EE 755. Cloud Computing. 3 Hours.**

This course covers fundamental and advanced concepts in cloud computing, including evaluation of current market offerings. Students will also design and implement systems integrating multiple cloud computing services.

**EE 756. Introduction to Big Data Analytics. 3 Hours.**

This course covers an introduction to the field of big data analytics, including technologies, challenges, architecture, and hypothesis testing.

**EE 758. Machine Learning in Engineering. 3 Hours.**

This course covers techniques for developing solutions to complex problems in different engineering domains without having to explicitly program the computers. Topics include supervised and unsupervised learning, classification and regression, support vector machines.

**EE 767. Advanced Brain Machine Interface. 3 Hours.**

This course addresses four major topics: 1) neuroscience and electrode interfaces, 2) front-end circuit design, 3) power/data links and graphical user interface, and 4) circuit, wireless link, and safety simulating software-learning parts.

**EE 782. Multivariable Systems. 3 Hours.**

Analysis and design of multiple-output, multiple-input control systems.

**EE 788. Enterprise Perspectives in Information Engineering. 3 Hours.**

Technology entrepreneurship, business processes, measurement of information systems effectiveness and productivity, building a responsive information infrastructure. Business system analysis, design, and process redesign. Reengineering and information systems evolution. Electronic commerce technical design. Legal considerations and governmental regulations and requirements. Ethics. Information system engineering.

**EE 790. Special Topics in (Area). 1-6 Hour.**

Special topics selected by faculty for PhD students.

**EE 791. Individual Study in (Area). 1-6 Hour.**

Individual study in area selected by faculty for PhD students.

**EE 798. Non-Dissertation Research. 1-12 Hour.**

Individual research in selected problem by faculty for PhD students.

**EE 799. Dissertation Research. 1-12 Hour.**

PhD dissertation research.

**Prerequisites:** GAC Z