Computer Engineering

Degree Offered	PhD in Computer Engineering
Website	https://www.uab.edu/engineering/ece/
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Program Information

The PhD degree prepares students for professional and research careers in industry and academia. The PhD in Computer Engineering is awarded by UAB and is offered through a program shared with the University of Alabama in Huntsville (UAH), allowing both UAB and UAH to contribute to the program.

Admission Requirements

Requirements for admission to the PhD program include the following:

1. A bachelor's degree in an accredited electrical or computer engineering program or a bachelor's degree in a related program acceptable to the graduate faculty in Electrical and Computer Engineering; students not having a bachelor's degree in electrical or computer engineering may be required to complete prerequisite courses, which will be defined at the time of admission.
2. An overall GPA of at least 3.0 on a 4.0 point scale, or at least 3.0 for the last 60 semester hours completed; and
3. Three letters of recommendation concerning the applicant's previous academic and professional work.
4. International applicants must submit English proficiency scores in accordance with UAB Graduate School requirement. Click here for details;
5. Original transcripts from all colleges and universities attended since high school must be sent directly to the UAB Graduate School (detailed instructions are included during the online application process);

Financial Support

Fellowships and/or assistantships may be available for well-qualified students admitted into the PhD program. In order to be considered for financial aid for the coming academic year, the completed application materials must usually be received at UAB by April 1.

There are a number of minority fellowships available through the Graduate School. Contact the UAB Graduate School directly for further information.

Additional Information

Deadline for Entry Term(s):	Fall: August 1; Spring: December 1; Summer: May 1
Deadline for All Application Materials to be in the Graduate School Office:	Seven days before the start of the term

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Committee and Candidacy Requirements

In addition to completing coursework requirements (see below), doctoral students must form a Graduate Dissertation Committee consisting of at least five faculty members, including the primary research mentor. At least two committee members must have a primary appointment at UAB in the Department of Electrical and Computer Engineering and one must have a primary appointment at UAH in the Electrical and Computer Engineering Department.

A comprehensive examination is required of all doctoral candidates. This exam is given after:

- All coursework is completed,
- Successful completion of GRD 717 Principles of Scientific Integrity, and
- The student's Graduate Committee, which consists of faculty representatives from both campuses, deems the student to have adequate preparation in the major and minor fields of study.

The examination is conducted by the Graduate Committee and administered on the resident campus. The examination consists of a written part and an oral part. The student presents a dissertation proposal during the oral portion of the examination. The comprehensive examination may only be taken twice.

After successfully passing the exam and defense, the graduate student will then enter into doctoral candidacy. Doctoral candidates must complete a minimum of 24 hours of dissertation research and then develop a dissertation for review by the dissertation committee. The candidate must also present an oral public defense of their dissertation. This must take place at least two semesters before the student may graduate. If the defense is successful, the student then has 10 working days to revise the dissertation and submit its approved form to the Graduate School by the published deadline.

Additional Academic Policies

Special Topics (590/690/790) courses and Independent Study (591/691/791) courses are reviewed for degree applicability for each program in the School of Engineering. No more than 6 combined credit hours of Special Topics and/or Independent Study courses will be applied to the Computer Engineering PhD without appeal to and approval from the Program Director.

The School of Engineering offers similar courses at the 400/500 and 600/700 levels. While the higher numbered course has more advanced content, there is a significant overlap in topics. Therefore, students are not allowed to take a 500-level or 700-level course for credit if they have previously taken the related 400-level or 600-level course, respectively.

Post Bachelor Requirements

Students entering the PhD program with a bachelor degree are required to complete at least 48 credit hours of coursework followed by 24 credit hours of dissertation research.

- 18 credit hours of approved coursework in computer engineering
- 12 credit hours of approved coursework in electrical or computer engineering
- 9 credit hours of approved coursework in mathematics, theoretical or formal methods as related to computer engineering

- 6 credit hours of approved coursework in fields that support the dissertation research
- 3 credit hours of GRD 717 Principles of Scientific Integrity
- 24 credit hours of EE 799 Dissertation Research

Post Master Coursework Requirements

Students entering the PhD program with a master degree are required to complete at least 27 credit hours of coursework followed by 24 credit hours of dissertation research.

- 9 credit hours of approved coursework in computer engineering
- 6 credit hours of approved coursework in electrical or computer engineering
- 6 credit hours of approved coursework in mathematics, theoretical or formal methods as related to computer engineering
- 3 credit hours of approved coursework in fields that support the dissertation research
- 3 credit hours of GRD 717 Principles of Scientific Integrity
- 24 credit hours of EE 799 Dissertation Research

Courses

EE 512. Practical Computer Vision. 3 Hours.
This course covers the 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 521. Communication Systems. 3 Hours.
This course covers the mathematics of modulation and demodulation of radio signals to transmit and receive information. It focuses on various forms of amplitude modulation (AM), phase and frequency modulation (FM). This course builds on the mathematics from signals and systems course to study how to represent and manipulate these signals in both time and frequency domain. It also studies the effects of sampling, and how these systems operate in the presence of noise.

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. Industrial Control. 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 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 the application of the Internet of Things (IoT).

EE 538. Computer Architecture. 3 Hours.
dvanced microprocessor topics include a comparison of advanced contemporary microprocessors, cache design, pipelining, superscalar architecture, design of control units, microcoding, and parallel processors. Basic knowledge of microprocessors is recommended.

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 the development of applications for the 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 the 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 563. Medical Image Analysis. 3 Hours.
A lab-based introduction to processing, analysis, and display techniques for medical imaging.

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, simulation, 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 a steady state.

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. A power system design project is 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 issues, liability, sustainability and reliability through the lends 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 delivered by faculty, research assistants, and invited guests in various state-of-the-art and popular topics related to Electrical and Computer Engineering.

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 transconductance 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 the 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.
The course covers topics in 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 630. Short-Range Wireless Systems. 3 Hours.
This course covers the short-range wireless power transmission (WPT), wireless data communication, and wireless sensor technologies. It emphasizes fundamental understanding of the principles and design procedure of short-range wireless power/data transfer systems as well as the various parameters involved in the optimization of wireless power/data transmission systems.

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 a 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 the design of Complex Programmable Logic Devices (CPLDs) and Field Programmable Gate Arrays (FPGAs). Topics include the 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 the 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 (CRC), 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 continuous-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 the 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 the theory and practice of numerical methods for a broad spectrum of engineering applications and data analyses. Topics include 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, detection of a signal in the noise, and function fitting. This course 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 an 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 methods. Adaptive 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 660. Medical Signal Processing. 3 Hours.
This course covers the theory and practice of processing and analyzing single-channel and multiple-channel medical signals. The topics include linear and nonlinear filtering, cross-estimation, autoregressive and spectral modeling, entropy, principal component analysis (PCA), classification, and clustering methods.

EE 667. Advanced Brain Machine Interface. 3 Hours.
This course consists of four major parts: 1) neuroscience and interfaces, 2) brain imaging technologies, 3) front-end circuit design, 4) power/data links and graphical user interface, and 5) circuit, wireless link, and safety simulating software-learning parts.

EE 682. Electromagnetic Field Theory I. 3 Hours.
This course covers the modeling of materials and environments through the simulation of electromagnetic fields. It includes a wide variety of applications, including biomedical and the 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. Electrical and Computer Engineering Seminar. 1-3 Hour.
This course consists of research presentations delivered by faculty, research assistants, and invited guests in various state-of-the-art and popular topics related to Electrical and Computer Engineering.

EE 710. 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 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 721. Random Variables and Processes. 3 Hours.
Theory underlying analysis and design of communication, stochastic control, data gathering, and data analysis systems.

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 621 [Min Grade: C]

EE 726. Digital Image Processing. 3 Hours.
This course covers topics in 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 730. Short-Range Wireless Systems. 3 Hours.
This course covers the short-range wireless power transmission (WPT), wireless data communication, and wireless sensor technologies. It emphasizes fundamental understanding of the principles and design procedure of short-range wireless power/data transfer systems as well as the various parameters involved in the optimization of wireless power/data transmission systems.

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 the 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 the theory and practice of numerical methods for a broad spectrum of engineering applications and data analyses. Topics include 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 the noise, and function fitting. This course provides hands-on practical experience with programming numerical analysis algorithms.

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 in mobile computing. 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(SVM), boosting, and artificial neural networks.

EE 760. Medical Signal Processing. 3 Hours.
This course covers the theory and practice of processing and analyzing single-channel and multiple-channel medical signals. The topics include linear and nonlinear filtering, cross-estimation, autoregressive and spectral modeling, entropy, principal component analysis (PCA), classification, and clustering methods.

EE 767. Advanced Brain Machine Interface. 3 Hours.
This course consists of four major parts: 1) neuroscience interfaces, 2) brain imaging technologies, 3) front-end circuit design, 4) power/data links and graphical user interface, and 5) circuit, wireless link, and safety simulating software-learning parts.

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 an 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