Computer Engineering

Degree Offered  PhD in Computer Engineering
Website  https://www.uab.edu/engineering/ece/
Director  Leon Jololian, PhD
Phone  (205) 934-8440
E-mail  leon@uab.edu

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. The GRE general test is required for all applicants. Applicants must score a 156 or higher on the quantitative section of the GRE to be considered for admission.
3. In addition, a minimum score of 80 on the TOEFL (minimum of 18 on each subsection) or a 6.5 on the IELTS is required for international applicants whose native language is not English;
4. 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
5. Three letters of recommendation concerning the applicant’s previous academic and professional work.

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):  Each semester
Deadline for All Application Materials to be in the Graduate School Office:  Fall: August 1; Spring: December 1; Summer: May 1

Admissions Requirements
Admission decisions are made on the basis of prior education, GPA, test scores, personal statement, professional experience, and recommendations.

In addition to the Graduate School admission requirements, admission to the Computer Engineering PhD program includes the following:

- A bachelor’s degree in an accredited electrical engineering, computer engineering, electrical and computer engineering or a bachelor’s degree acceptable to the graduate faculty in the Department of Electrical and Computer Engineering. Students not having a bachelor’s degree in electrical engineering, computer engineering, electrical and computer engineering may be required to complete prerequisite courses based on their prior coursework and their plan of study, which will be defined at the time of admission.
- Minimum GPA of 3.0 on a 4.0 scale on most recent degree
- The GRE general test is required for all applicants who do not have significant post baccalaureate experience. As score of 156 or higher on the on the quantitative section of the GRE is recommended for admission.
- Personal statement identifying research interest
- CV/Résumé
- 3 recommendations from academic or professional contacts
- Official transcripts from each institution where college credit was received to be mailed to:

  UAB Graduate School
  LHL G03; 1720 2nd Avenue South
  Birmingham, AL 35294-0013

  Institutions can also submit official transcripts electronically by choosing University of Alabama at Birmingham – Graduate Admissions or using the email gradschool@uab.edu.

Additional International Requirements

- For applicants whose first language is not English, TOEFL score of 80 or higher (with a minimum score of 18 on each subsection) OR IELTS score of 6.5 or higher (Institution code – 1856. Applicable for the GRE and TOEFL only)
- Financial Affidavit of Support
- Immigration documentation if currently residing in the US

Coursework Requirements
Students entering the PhD program with a baccalaureate degree must, in keeping with UAB Graduate School policies, complete at least 48 hours of coursework prior to admission to candidacy. Up to 16 of the 48 credits can be non-dissertation research, and up to 10 credits can be a combination of laboratory rotations, seminars, and directed study.

Students entering the PhD program with a Master’s degree in a related field, MD, DMD, etc., must complete at least 27 credit hours of coursework prior to candidacy. Up to 6 credits of the 27 can be non-dissertation research credits, and up to 6 credits can be as lab rotations, seminars, or directed study credits.

For all students, at least 24 hours of dissertation research are required and must be taken over at least two semesters after admission to candidacy.

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 written dissertation proposal must be orally presented to the committee and approved, at which time the student is eligible for admission into candidacy. This must take place at least two semesters before the student may graduate. A written dissertation embodying the results of the student’s original research must then be publicly defended, approved by the committee, and submitted 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 review for degree applicability for each program in the School of Engineering. No more than 6 combined 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 semester hours of coursework followed by 24 semester hours of dissertation research.

- 18 semester hours of approved coursework in computer engineering
- 12 semester hours of approved coursework in electrical or computer engineering
- 9 semester hours of approved coursework in mathematics, theoretical or formal methods as related to computer engineering
- 6 semester hours of approved coursework in supportive fields
- 3 semester hours of GRD 717 Principles of Scientific Integrity
- 24 semester hours of EE 799 Dissertation Research

Students must be in candidacy prior to enrolling in EE 799 Dissertation Research. A student is eligible for admission to candidacy after (1) all coursework, including GRD 717, is complete and (2) a written dissertation proposal has been orally presented to and approved by the committee.

**Post Master Coursework Requirements**

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

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

Students must be in candidacy prior to enrolling in EE 799 Dissertation Research. A student is eligible for admission to candidacy after (1) all coursework, including GRD 717, is complete and (2) a written dissertation proposal has been orally presented to and approved by the committee.

**Courses**

**EE 511. Facilities Engineering. 3 Hours.**

General engineering project planning, applying codes and standards, preliminary design, economic forecasting, environmental planning/ reports, site selection, population displacement, cash flow, specifications and plans.

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

Fundamentals and applications of computer vision: image preprocessing, detection, segmentation, registration, classification and recognition, texture and color, visual tracking.

**EE 518. 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 318 (Methods of System Analysis) is a prerequisite for this course.

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

Digital filter analysis and design. FET algorithms. Applications of DSPs in engineering problems such as data acquisition, control, and I/O. Lecture and computer laboratory. EE 318 (Methods of System Analysis) is a prerequisite for this course.

**EE 526. Control Systems. 3 Hours.**

Theory of linear, continuous-feedback control systems using complex frequency techniques. Block diagram manipulation, performance measures, stability, root locus, construction and locating roots (positive and negative feedback), gain adjustment, and altering dynamic properties. Discrete transforms using z-transform and z-plane root locus.

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

Power control devices and applications. Relay logic and translation to other forms. Analog and digital computers. Proportional-integral-derivative (PID) control techniques. Modern laboratory instrumentation and man-machine interface software. Lecture and laboratory. EE 233 Engineering Programming Method, EE 318 (Methods of System Analysis), and EE 351 (Electronics) are prerequisites for this course.

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

Advanced analysis and design using op-amps, with emphasis on error analysis and compensation. Applications include signal conditioning for instrumentation, instrumentation amplifiers, nonlinear and computational circuits, Butterworth and Chebyshev filter design, power amplifier design, voltage regulator design, and oscillators. A-to-D and D-to-A conversion methods. Laboratory exercises emphasizing design techniques. EE 351 (Electronics) is a prerequisite for this course. EE 318 (Methods of System Analysis) is a prerequisite or may be taken concurrently with the course.

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

Introduction to computer networking and engineering standards related networking. Network hardware, Ethernet, token ring, ISDN, ATM, networking protocols including TCP/IP protocol suite, Internetworking, LANS, and typical applications.

**Prerequisites:** EE 134 [Min Grade: C] and EE 210 [Min Grade: C]
EE 533. Engineering Software Solutions. 3 Hours.
Project planning, specification, design, implementation and testing of software solutions for engineers. Waterfall model of development and agile development methods will be covered. Lecture and computer laboratory. Four projects. EE 333 (Engineering Programming using Objects) is a prerequisite for this course.

EE 534. Power and Radio-Frequency Semiconductor Electronics. 3 Hours.
Fundamentals of integrated circuit design for radio-frequency and power converter circuits. Course contents will include basics of RF circuit theory, matching networks, high frequency MOS model, low-noise-amplifier, voltage controlled oscillator, fundamentals of power electronics, power semiconductor switches, steady-state equivalent circuit modeling, DC transformer model, basic AC equivalent circuit modeling, linearization and perturbation, etc. Will require accomplishing a computer aided design, simulation and chip layout of an integrated circuit design project.

EE 537. Introduction to Embedded Systems. 3 Hours.
Applications of microprocessors in engineering problems such as data acquisitions control, and real-time input/output.

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. EE 337 (Introduction to Microprocessors) is a recommended prerequisite for this course.

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.
Hands-on laboratory course covering 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.
Focus on the development of applications and models using Internet/Intranet Technologies such as JavaScript, Conferencing systems, Dynamic HTML, server side scripting, multi-tier models and XML. Lecture and computer laboratory.
Prerequisites: EE 233 [Min Grade: C]

EE 548. Software Engineering Projects. 3 Hours.
Builds on the Object-Oriented concepts covered in EE 333. Coverage for Unified Modeling Language is expanded and design patterns are incorporated. Provides a project environment for implementation of systems using Object Oriented techniques.
Prerequisites: EE 333 [Min Grade: C]

EE 552. Digital Systems Design. 3 Hours.
Prerequisites: EE 337 [Min Grade: C]

EE 558. Medical Instrumentation. 3 Hours.
Fundamental operating principles, applications and design of electronic instrumentation used in measurement of physiological parameters. Class design project.
Prerequisites: EE 351 [Min Grade: C]

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 361 (Machinery I) is a prerequisite for this course.

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 stated. EE 351 (Electronics) is a prerequisite for this course.

EE 572. Power Systems II. 3 Hours.

EE 573. Protective Relaying of Power Systems. 3 Hours.
Operating principles of protective relays. Protection of transmission lines, generators, motors, transformers, and buses.

EE 574. Industrial Power Systems. 3 Hours.

EE 585. Engineering Operations. 3 Hours.
Economic, procedural, planning, and control aspects of engineering projects.

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.
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 605. Embedded Systems for Industrial Scholars. 3 Hours.
Embedded systems are commonplace in the integration age. From consumer applications to medical applications, embedded systems are within practically every system. Engineers developing all kinds of systems should be at least familiar with the possibilities available with embedded systems. This introductory course will cover basics of developing systems with embedded computing components. Various popular systems and languages will be exposed. Topics covered will include: Significance of embedded systems, embedded systems design, rapid system prototyping of embedded systems, use of FPGAs and other modern design strategies.

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. Successful performance on a written pre-test required.
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.
Prerequisites: EE 605 [Min Grade: C] and EE 606 [Min Grade: C] and EE 607 [Min Grade: C] and EE 608 [Min Grade: C] and EE 609 [Min Grade: C] and EE 611 [Min Grade: C] and EE 612 [Min Grade: C] and EE 613 [Min Grade: C]

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 421 [Min Grade: C]

EE 623. Computer Vision. 3 Hours.
Advanced topics in computer vision: image segmentation, registration, and visual tracking. (EE 412:512 - Practical Computer Vision or EE 300 - Engineering Problem Solving + EGR 265 - Mathematical Tools for Engineering Problem Solving or other equivalent courses).

EE 624. Digital Communications. 3 Hours.
Design of digital communications systems.

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.

EE 626. Digital Image Processing. 3 Hours.
Digital image processing fundamentals, image transformations, image enhancement, image restoration, image compression, image segmentation, and image presentation.
Prerequisites: EE 318 [Min Grade: C]

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 628. Telecommunications I. 3 Hours.
Advanced topics.

EE 629. Telecommunications II. 3 Hours.
Advanced Topics.

EE 632. Introduction to Computer Networking. 3 Hours.
Prerequisites: EE 333 [Min Grade: C] and EE 210 [Min Grade: C]

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.
Neural network topologies and learning algorithms with an emphasis on back propagation. Applications and limitations of networks. Designing networks for specific uses. Individual software project. A grade of C or better in EE 210 (Digital Logic) is required for this course.

EE 635. Telecommunication Systems. 3 Hours.
System organization and structure; data transmission.

EE 636. Advanced Digital Design. 3 Hours.
Large-scale class project. Sample topics include math coprocessors, text coprocessors, CRT controllers, and data encryption devices.

EE 637. Design of Modern Computer with Digital Integrated Circuits. 3 Hours.
This course will cover the basic design flow of digital computing chips. Students will be exposed to all levels of the chip design flow. The course will involve design projects that utilize the industry-grade software suite from Cadence. The course will use Silicon based Metal Oxide Semiconductor Field Effect Transistor (MOSFET) technology, which is current, for computer chip design. It will also briefly introduce two of the popular emerging technologies, Carbon based transistors and interconnects and 3-DimensionalICs. Requires a basic understanding of transistors and digital logic.

EE 639. Embedded Systems. 3 Hours.
Topics covering both hardware and software issues. Individual or group term project. Course is for MSEE and PhD in Computer Engineering.

EE 640. Object-Oriented Design. 3 Hours.
Study and practice of the object-oriented methodology for developing software designs. Implementation consequences. Application of object-oriented methodologies to specific problems using an object-oriented language. A grade of C or better in EE 333 (Engineering Programming using Objects) or other software design experience using C is required for this course.

EE 641. Modern Control Theory. 3 Hours.
State variable models for discrete-time systems. Sampled-data systems. State feedback and pole placement. State estimation. Control Systems (EE 426) is a suggested prerequisite for this course.

EE 642. Intelligent Systems. 3 Hours.

EE 650. Software Engineering. 3 Hours.
Introduces classical software lifecycles and software development paradigms. Provides state-of-the-art practical experience in proposal development and software design. Develops integrated skills drawing experience from computer engineering, computer science, communication, systems engineering, and problem solving.

EE 651. Software Engineering Large Systems - I. 3 Hours.
Introduces advanced integrated software systems development paradigms. Notions of process and integrated system views are extensively covered. Modeling-in-the-large and modeling-in-the-small are discussed and related to levels in Object Oriented Design and Programming.

EE 652. Software Engineering Large Systems - II. 3 Hours.
Builds on the advanced integrated software systems development paradigms covered in EE 651/751. Components are introduced as elements of large system implementations. In the context of a design taxonomy, advanced Object Oriented design and development techniques are reviewed.
EE 653. Electronic Power Switching Circuits. 3 Hours.
Power semiconductor devices. Switching circuit analysis, AC voltage controllers, controlled rectifiers, DC-to-DC converters, inverters, and cyclo-converters.
Prerequisites: EE 351 [Min Grade: C]

EE 654. Mobile Computing. 3 Hours.
Fundamental 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 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.
Introduction to the field of big data analytics, including technologies, and challenges, architecture and hypothesis testing.

EE 658. Machine Learning in Engineering. 3 Hours.
Machine learning includes the science, engineering, and techniques for developing solutions to complex problems without having to explicitly program the computers. Beginning with classification and linear regression, the course covers topics that include supervised and unsupervised learning, boosting, support vector machines, Neural Networks, Convolution Neural Networks, and Recurrent Neural Networks. The course provides students with the theoretical underpinnings of machine learning as well as the practical knowledge to design and implement solutions to problems in different domains. Students will be asked to work on biweekly assignments and to develop a course project demonstrating their understanding of the major concepts presented in this course.

EE 661. Advanced Synchronous Machines. 3 Hours.
Effects of synchronous machine design on generated voltage and harmonics. Time domain modeling and simulation of machine dynamics for transient stability analysis.

EE 662. Advanced Induction Machines. 3 Hours.
Time domain modeling of induction machines. Simulation of induction machine dynamics including motor starting transients.

EE 663. Control of Synchronous Machines. 3 Hours.

EE 671. Computer Applications in Power Systems. 3 Hours.
Analysis of power systems operation.

EE 672. Power System Overvoltages. 3 Hours.
Events causing overvoltages, and protection of system.

EE 673. Reliability of Power Systems. 3 Hours.
Component reliability using standard industrial techniques.

EE 674. Economic Operation and Control of Power Systems. 3 Hours.
Economic control of thermal generating stations and hydrothermal stations. Computer control of power systems.

EE 682. Electromagnetic Field Theory I. 3 Hours.
Application of Maxwell's equations to problems of electrical engineering; boundary-value problems, wave propagation, waveguides, radiation, and scattering; and surface waves.

EE 683. Complex Frequency Techniques in Process Control. 3 Hours.
S-plane techniques; characterization of processes; design of controllers.

EE 688. Enterprise Perspectives in Information Engineering. 3 Hours.

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

EE 691. Individual Study in (Area). 1-6 Hour.
Topic assigned with course.

EE 697. Graduate Project. 3 Hours.
Graduate project for Plan II Masters 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.

EE 723. Computer Vision. 3 Hours.
Advanced topics in computer vision: Image segmentation, registration, and visual tracking. Linear algebra, PDE or basic computer vision (EE 412:512 - Practical Computer Vision or EE 300 - Engineering Problem Solving + EGR 265 - Mathematical Tools for Engineering Problem Solving or other equivalent courses).

EE 724. Digital Communications. 3 Hours.
Design of digital communications systems.

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.

EE 726. Digital Image Processing. 3 Hours.
Digital image processing fundamentals, image transformations, image enhancement, image restoration, image compression, image segmentation, and image presentation.
Prerequisites: EE 318 [Min Grade: C]

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 728. Telecommunications I. 3 Hours.
Advanced topics.

EE 729. Telecommunications II. 3 Hours.
Advanced Topics.
EE 732. Introduction to Computer Networking. 3 Hours.
Computer network fundamentals. Layered network OSI 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. Digital Logic (EE 210) and Introduction to Microprocessors (EE 337) are recommended prerequisites for this course.

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.
Neural network topologies and learning algorithms with an emphasis on back propagation. Applications and limitations of networks. Designing networks for specific uses. Individual software project. EE 426 (Control Systems) and a grade of C or better in EE 210 (Digital Logic) are prerequisites for this course.

EE 737. Design of Modern Computers with Digital Integrated Circuits. 3 Hours.
This course will be focused on teaching the basic design flow of digital computing chips. The students will be exposed to all levels of the chip design flow. The course will involve design projects that utilize an industry-grade software suite from Cadence. The course will use Silicon based Metal Oxide Semiconductor Field Effect Transistor (MOSFET) technology, which is current, for computer chip design. It will also briefly introduce two of the popular emerging technologies, Carbon based transistors and interconnects (3-Dimensional ICs). Requires basic understanding of transistors and digital logic.

EE 740. Object-Oriented Design. 3 Hours.
Study and practice of the object-oriented methodology for developing software designs. Implementation consequences. Application of object-oriented methodologies to specific problems using an object-oriented language. Requires a knowledge of software design experience using C.

EE 742. Intelligent Systems. 3 Hours.

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.
Introduces classical software lifecycles and software development paradigm. Provides state-of-the-art practical experience in proposal development and software systems design. Develops integrated skills drawing experience from computer engineering, computer science, communication, system engineering, and problem solving.

EE 751. Software Engineering Large Systems - I. 3 Hours.
Introduces advanced integrated software systems development paradigms. Notions of process and integrated system views are extensively covered. Modeling-in-the-large and modeling-in-the-small are discussed and related to levels in Object Oriented Design and Programming.

EE 752. Software Engineering Large Systems - II. 3 Hours.
Builds on the advanced integrated software systems development paradigms covered in EE 651/751. Components are introduced as elements of large system implementations. In the context of a design taxonomy, advanced Object Oriented design and development techniques are reviewed.

EE 754. Mobile Computing. 3 Hours.
Fundamental 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.
Introduction to the field of big data analytics, including technologies, and challenges, architecture and hypothesis testing.

EE 758. Machine Learning in Engineering. 3 Hours.
Machine learning includes the science, engineering, and techniques for developing solutions to complex problems without having to explicitly program the computers. Beginning with classification and linear regression, the course covers topics that include supervised and unsupervised learning, boosting, support vector machines, Neural Networks, Convolution Neural Networks, and Recurrent Neural Networks. The course provides students with the theoretical underpinnings of machine learning as well as the practical knowledge to design and implement solutions to problems in different domains. Students will be asked to work on biweekly assignments and to develop a course project demonstrating their understanding of the major concepts presented in this course.

EE 761. Advanced Synchronous Machines. 3 Hours.
Effects of synchronous machine design on generated voltage and harmonics. Time domain modeling and simulation of machine dynamics for transient stability analysis.

EE 762. Advanced Induction Machines. 3 Hours.
Time domain modeling of induction machines. Simulation of induction machine dynamics including motor starting transients.

EE 763. Control of Synchronous Machines. 3 Hours.
Component reliability using standard industrial techniques.

EE 771. Computer Applications in Power Systems. 3 Hours.
Analysis of power systems operation.

EE 772. Power System Overvoltages. 3 Hours.
Events causing overvoltages, and protection of system.

EE 773. Reliability of Power Systems. 3 Hours.
Component reliability using standard industrial techniques.

EE 774. Economic Operation and Control of Power Systems. 3 Hours.
Economic control and operation of thermal generating stations and hydrothermal stations. Computer control of power systems.

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.

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

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

EE 798. Non-Dissertation Research. 1-12 Hour.
EE 799. Dissertation Research. 1-12 Hour.
Prerequisites: GAC Z