SIU CARBONDALE Southern Illinois University

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Electrical and Computer Engineering

Graduate Programs and Research Areas

The School of Electrical, Computer, and Biomedical Engineering (ECBE) offers programs of study and research leading to: i) the Master of Engineering (M.E.) degree in Electrical and Computer Engineering, ii) the Master of Science (M.S.) degree (thesis/non-thesis) in Electrical and Computer Engineering, and iii) the Doctor of Philosophy (Ph.D.) degree in Electrical and Computer Engineering.

The School provides a rich environment for educational, research, and professional advancement in the following areas:

1. **Electrical Systems**: Electric Energy & Renewables, Power Systems, Electricity Markets, Electric Vehicles, Optics & Photonics, Optical Imaging, Antennas.
2. **Microelectronics**: Electronic Design Automation, Emerging Nanoscale and Quantum Technologies, VLSI Circuits, Integrated Systems, 3-D Chip Design, Sensors, Electronics for Harsh Environments.
3. **Signals and Communications**, **and Control**: Image Processing, Signal Processing, Computer Vision, Telecommunications, Communication Networks, Wireless Energy Harvesting for IoTs, Terahertz Technology, Control Systems, Robotics.
4. **Hardware and Firmware**: Computer Architectures, Embedded Systems, Network Systems, Robotics, Programmable Logic Controllers, Internet of Things (IoT) Devices.
5. **Systems Software**: Machine Learning, Artificial Intelligence, Cloud Computing, Energy-Aware Computing, Digital Design Automation, Multi-Core Programming, High-Performance Scientific Computing, Operating Systems, Software Engineering, Systems Programming.
6. **Medical Devices:** Biomedical Instrumentation, Biomedical Imaging, Advanced Manufacturing, Biophotonics and Medical Electronics, Biosensors.
7. **Biological Systems:** Drug Screening and Precision Diagnostics, Neural Stimulation and Pain Analysis, Kinematics and Mechanobiology.

The ECBE programs of study provide a balance between formal classroom instruction and research, and are tailored to the individual student's academic and professional goals. Graduates of the program enjoy excellent employment opportunities and are highly recruited worldwide in industry, government, and academia.

Admission, degree requirements, graduation, and time limits are subject to the general guidelines of the Graduate School.

Master of Engineering (M.E.) in Electrical and Computer Engineering

Objectives

The program is designed to allow a graduate student to earn a non-thesis Master of Engineering (M.E.) degree in Electrical and Computer Engineering in 2-3 semesters (with the possibility of completing within one year). The M.E. in Electrical and Computer Engineering program is coursework-oriented and is inclined towards professional development, allowing more flexibility in taking online/distance education hours.

Admission

The M.E. in Electrical and Computer Engineering program is designed for individuals holding a Bachelor's degree in electrical or computer engineering or related field. Qualified applicants with Bachelor's degrees in other areas of engineering and science may be able to enroll in the program with additional preparation (approved by the School on a case-by-case basis). The applicants must indicate whether they are pursuing the degree online or on campus.

Admission to the M.E. in Electrical and Computer Engineering program is based on the following factors: grade point average of 2.75 or higher on a scale of 4.0 on the entire last undergraduate GPA earned at the time of application, class ranking, and faculty recommendation letters. Exceptions can be made on a case-by-case basis. GRE scores are not required for admission. However, they are important to qualify for the High Achievers Tuition Rate. See https://tuition.siuc.edu/highachievers2.html. The English proficiency requirement and any applicable exemptions will be determined according to Graduate School guidelines.

Curriculum

The program requires a total of 30 credit hours of graduate-level credit. ECE 592, ECE 580 (Seminar), and ECE 599 will not count toward the degree. At least six credit hours must be in ECE 500-level courses that do not have significant overlap/similarity with ECE 300/400-level courses, as stated in their catalog description. Online/distance education hours offered by the University and approved by the School could be applied to the degree. Also, a maximum of six credit hours of non-ECE courses offered by the University and approved by the School could be applied towards the degree. These courses may include topics such as business fundamentals, entrepreneurship, management, and leadership.

A student pursuing the M.E. in Electrical and Computer Engineering degree could switch to the corresponding M.S. in Electrical and Computer Engineering program upon recommendation of ECBE faculty and with the approval of the School, provided admission requirements of the M.S. in Electrical and Computer Engineering degree are met.

Retention

Any student whose cumulative grade point average falls below 3.0 on courses that count towards the degree will be placed on academic probation. Any graduate student on academic probation whose grade point average remains below 3.0 on courses that count towards the degree for two consecutive semesters in which they are enrolled will be permanently suspended from the program, unless the School grants an exception.

Master of Science (M.S.) in Electrical and Computer Engineering

Objectives

The Master of Science (M.S.) in Electrical and Computer Engineering program has two tracks: i) The non-thesis track is coursework-oriented; ii) The thesis track is research-oriented. The applicants must indicate whether they are pursuing the thesis or the non-thesis track degree option.

Admission

Individuals holding a Bachelor's degree in electrical or computer engineering or related field may apply. Qualified applicants with Bachelor's degrees in other areas of engineering and science may be able to enroll in the program with additional preparation (approved by the School on a case-by-case basis).

Admission to the M.S. in Electrical and Computer Engineering program is based on the following factors: grade point average of 3.0 or higher on a scale of 4.0 on the entire last GPA earned at the time of application, class ranking, and faculty recommendation letters. Exceptions can be made on a case-by-case basis. GRE scores are not required for admission. However, they are important to qualify for the High Achievers Tuition Rate. See https://tuition.siuc.edu/highachievers2.html. Also, GRE scores, especially Quantitative, may be considered for fellowships/assistantships/scholarships. The English

proficiency requirement and any applicable exemptions will be determined according to Graduate School guidelines.

Curriculum

The program requires a total of 30 hours of graduate-level credit. For the non-thesis track, at least nine credit hours must be in ECE 500-level courses that do not have significant overlap/similarity with ECE 300/400-level courses, as stated in their catalog description. ECE 592, ECE 580 (Seminar), and ECE 599 will not count towards the degree. A maximum of three credit hours of non-ECE courses offered by the University and approved by the School could be applied towards the degree. Students in the non-thesis track are required to take a Comprehensive Examination. The Comprehensive Examination, in whole or in part, cannot be taken more than two times and students must pass the examination before graduation. The Comprehensive Examination, which is administered by the ECBE Graduate Studies Committee, will be offered in the second week of February and the second week of September.

For the thesis track, six credit hours of thesis (ECE 599) are required. At least six credit hours must be in ECE 500-level courses (excluding ECE 592 and ECE 599) that do not have significant overlap/similarity with ECE 300/400-level courses, as stated in their catalog description. A maximum of three credit hours of ECE 592 could be counted towards the degree requirements. ECE 580 (Seminar) will not count towards the degree. A maximum of three credit hours of non-ECE courses offered by the University and approved by the School could be applied towards the degree. The student must have a thesis advisor on file within the first semester of enrollment. Students in this track will develop a program of study in consultation with their thesis advisor. The M.S. thesis shall be supervised by a committee of three members of the graduate faculty (including the advisor) and approved by the School. The student must submit a properly formatted written thesis to the thesis committee. A student will be recommended for the degree according to the guidelines of the Graduate School.

A student pursuing the M.S. in Electrical and Computer Engineering degree could switch track (non-thesis to thesis or vice versa) or switch to the M.E. in Electrical and Computer Engineering program upon recommendation of ECBE faculty and with the approval of the School.

Retention

Any student whose cumulative grade point average falls below 3.0 on courses that count towards the degree will be placed on program academic probation. Any graduate student on academic probation whose grade point average remains below 3.0 on courses that count towards the degree for two consecutive semesters in which they are enrolled, excluding summer sessions, will be permanently suspended from the program, unless the School grants an exception.

Accelerated Master’s Program

Objectives

The Accelerated Master’s Program is designed for high-achieving students who are currently enrolled in an undergraduate program in the School. The program will allow students to earn both a Bachelor’s degree and a Master’s degree within five years by completing 147 credit hours (instead of 156 credit hours if pursuing Bachelor’s and Master’s studies separately).

Admission

Apply as early as the beginning of the first semester of junior year for acceptance into the program. Work with the undergraduate Academic Advisor (and a potential graduate faculty advisor, if needed) to develop a program of study identifying 9 credit hours that may be counted towards both the Bachelor’s degree and the Master’s degree.

Students are considered as undergraduates until all requirements for the Bachelor’s degree have been fulfilled. For the Master’s degree, they will have the option to select either the M.S. in Electrical and Computer Engineering (thesis/non-thesis) or the M.E. in Electrical and Computer Engineering degree.

Curriculum

Junior/Senior Year - Complete up to nine graduate-level ECE credit hours during the junior/senior year taken from the School of Electrical, Computer, and Biomedical Engineering (excluding ECE 492, ECE 592, and BME 592). At most nine graduate-level ECE credit hours will be counted towards both the Bachelor's and the Master's degree requirements. Graduate Year - Complete the remaining Master's coursework and other requirements within one year of full-time graduate study.

Retention

Any graduate student whose cumulative grade point average falls below 3.0 on courses that count towards the Master's in Electrical and Computer Engineering degree will be placed on program academic probation.

Doctor of Philosophy (Ph.D.) in Electrical and Computer Engineering

Objectives

The program is designed to achieve the following academic objectives:

1. to fulfill the obligation of the School of Electrical, Computer, and Biomedical Engineering to provide high-quality education through the doctoral level as is mandated by the mission statement of the University;
2. to provide the students with the training necessary to successfully apply the fundamental concepts and methods of electrical and computer engineering to specific areas of research and development;
3. to provide the graduates with the ability to independently organize and conduct research in electrical and computer engineering;
4. to provide the graduates with the ability to concisely disseminate existing and new knowledge and to accurately present their research plans in writing.

Admission

Admission to the program normally requires a Master's degree in Electrical or Computer Engineering or a related field. Applicants with exceptional research potential or outstanding academic qualifications may be considered for direct entry into the program after completion of a Bachelor's degree in Electrical or Computer Engineering or a related field. Students currently enrolled in a Master's program in the School may be considered for accelerated entry into the program upon the recommendation of the faculty in the School.

Individuals holding a Master's degree with a GPA of 3.25/4.0 or higher may apply. For direct and accelerated entry, a Bachelor's degree with a GPA of 3.0/4.0 or higher is required. Exceptions can be made on a case-by-case basis and will be reviewed by the ECBE Graduate Affairs Committee. All applications for admission must include the following: a statement of research interest, transcripts, official GRE scores, and three reference letters. The English proficiency requirement and any applicable exemptions will be determined according to Graduate School guidelines.

Advisement

The student must have an advisor on file within the first semester of enrollment. The advisor will assist the student in defining the area of research (the core), and developing a plan of study. Students should also make themselves familiar with the degree timeline, program requirements, expected scholarly outcomes, parameters used to assess the performance at various stages, and the opportunities of (and expectations for) fellowships or scholarships.

Retention

Any graduate student whose cumulative grade point average falls below 3.25 on courses that count towards the degree will be placed on academic probation. Any graduate student on academic probation whose grade point average remains below 3.25 on courses that count towards the degree for two consecutive semesters in which they are enrolled, excluding summer sessions, will be permanently suspended from the program, unless the School grants an exception.

Curriculum

1. 12 credit hours of ECE 500-level courses (excluding ECE 592 and ECE 599) that do not have significant overlap/similarity with ECE 300/400-level courses, as stated in their catalog description. Nine credit hours of ECE 500-level courses that do not have significant overlap/similarity with ECE 300/400-level courses constitute the core. The objective of the core is to provide the candidate with the foundation necessary to engage successfully in the selected research area.
2. For applicants with a Master's degree, nine credit hours of other graduate-level ECE courses (excluding ECE 599). For direct and accelerated entries, 15 credit hours of other graduate-level ECE courses (excluding ECE 599).
3. Three credit hours of graduate-level mathematics or science or a non-ECE engineering course offered by the University and approved by the School; and
4. 24 dissertation credit hours.

A maximum of three credit hours of ECE 592 could be counted towards the degree requirements. ECE 580 (Seminar) will not count towards the degree.

Qualifying Examination

A student will take the Qualifying Examination within the first year of residency in the program. The written examination, given by three different ECBE voting faculty members with graduate status, covers at least three major research areas of ECBE. The student must score at least 75 percent in each area tested. If not successful, the committee may allow the student to repeat the whole or part of the examination. The Qualifying Examination, in whole or in part, cannot be taken more than two times. The examination is administered by the ECBE Graduate Studies Committee.

Preliminary Examination

Following the successful completion of the Qualifying Examination and the core courses (which satisfy the research tool requirement of the Graduate School), the student will be allowed to take the Preliminary Examination. Before taking the examination, the student must form a preliminary examination committee consisting of five faculty members with at least one (but not more than two) outside the School. The student's faculty advisor shall be one of the five members and shall chair this committee.

The student must prepare and submit a formal written proposal of original research, defining the proposed line of inquiry, rationale, a solid plan to conduct the proposed research, and the expected outcomes. The student subsequently must make an oral presentation of the proposal to the members of the preliminary examination committee. The student is expected to address and respond to any questions related to the materials covered by the relevant courses taken during their doctoral studies or to the background necessary for the specific area of the proposed research. In addition, the student is expected to defend the research methodology and the proposed line of inquiry. The Preliminary Examination, in whole or in part, cannot be taken more than two times.

Candidacy

Admission to candidacy requires: (a) passing the Qualifying Examination and completion of the core courses (which satisfies the research tool requirement of the Graduate School), (b) passing the Preliminary Examination, and (c) successful completion of 24 credit hours (which satisfies the residency requirement of the Graduate School).

Dissertation Committee

Following the admission to candidacy, the School Director in consultation with the student's advisor (dissertation supervisor) appoints the dissertation committee, which shall consist of five faculty members with at least one (but not more than two) outside the School. The student's dissertation supervisor shall be one of the five members and shall chair this committee. The dissertation supervisor must be an ECBE faculty and have Direct Dissertation status. A non-ECBE faculty member with Direct Dissertation status may serve as a co-supervisor.

Dissertation

Students in the program will be expected to work towards their Ph.D. dissertation research as soon as they are admitted to candidacy.

The dissertation must be prepared in accordance with the guidelines of the Graduate School. Dissertation approval is based on the successful defense of the research performed in terms of originality, relevance, and presentation (written and oral).

Dissertation Defense

Upon completion of the dissertation, which must demonstrate the ability of the candidate to conduct independent research, the committee will administer the final oral examination. The objective of the final oral examination, conducted in an open forum, will be the defense of the dissertation. Upon satisfactory completion of the dissertation and the final oral examination, the committee will recommend the candidate for the doctoral degree.

Technical writing and oral presentation skills are important, particularly for a possible academic career. The dissertation committee shall evaluate the candidate's skills both in technical writing and oral presentation. A student will be recommended for the degree according to the guidelines of the Graduate School.

Graduation

The student must complete the curriculum with a minimum grade point average of 3.25 on courses that count towards the degree.

Electrical and Computer Engineering Courses

ECE494 - Diagnostic Ultrasound Diagnostic ultrasound is an ultrasound-based biomedical imaging technique used to visualize muscles, tissue, and many internal organs, to capture their size, structure and any pathological lesions. This course is an introduction to the principles and applications of biomedical ultrasound. This course will focus on fundamentals of acoustic theory, principles of ultrasonic detection and imaging, design and use of currently available tools for performance evaluation of diagnostic devices, and biological effects of ultrasound. Prerequisite: MATH 305 and ECE 355 with a grade of C or consent of instructor. Restricted to enrollment in ECE programs. Lab fee: $30 to help defray cost of equipment, supplies, and software licenses. Credit Hours: 3

ECE501 - Data Mining with R R programming language: Vectors, Matrices, Lists, Data Frames, Factors, Tables. Review of machine learning techniques: Numerical Regression, Logistic Regression, k-Nearest Neighbors, Decision Trees. ROC curves. Various application case studies. Restricted to graduate standing and consent of instructor. Students who have completed ECE 435 or BME 435 will not receive credit for this course. Credit Hours: 3

ECE502 - Network System Security Principles, design, and implementation of network systems security. Network security basics (computer networks and network security module), packet sniffing and spoofing, network security systems (firewall, virtual private network, and instruction detection systems), security tools (AES, Hash, RSA, and public key infrastructure), and advanced topics such as bitcoin and

block chain. Students who have completed ECE 433 will not receive credit for this course. Restricted to graduate standing and consent of instructor. Credit Hours: 3. Credit Hours: 3

ECE503 - Modern Cryptography Probability and basic number theory, block ciphers and key-recovery security, pseudorandom functions, symmetric encryption, hash functions, message authentication codes, authenticated encryption, asymmetric encryption, digital Signatures, key distribution, lattice-based cryptography, identity-based encryption, zero-knowledge e techniques, introduction to quantum cryptography. Credit Hours: 3

ECE504 - Hardware and Software Aspects in the Internet of Things Fundamentals and importance of the Internet of Things (IoT). Sensors and hardware components of IoT systems. Design of energy-efficient IoT systems from circuit to system level. Connectivity in IoT, off-loading strategies, and federated learning concepts. Applications of IoT in smart cities, healthcare, agriculture, and augmented/virtual Reality. Prerequisites: ECE 329 and ECE 321 (or equivalent) with a grade of C or better or consent of instructor. Credit Hours: 3

ECE505 - Surgical Technologies Overview of the ordinary physiology of cells and tissues and the abnormal physiology associated with cancer and/or other major diseases. Role of surgeries in the practice of modern medicine with a special focus on cancer treatment and/or other important procedures. Environment of and people inside the operating room. Therapeutic and diagnostic tools and techniques available in the operating room. Open and minimally invasive surgeries. Introduction to image-guided surgeries. Imaging systems and contrast agents for image-guided surgeries. Introduction to robotic surgeries. Preclinical research, clinical research, and FDA-approval process. Prerequisite: ECE 355 (or equivalent). Credit Hours: 3

ECE506 - Biomedical Optics (Same as BME 506) Fundamental theories of light, including the wave theory of light and the particle theory of light; Fundamental interactions between light and matter, including reflection, refraction, absorption, scattering, fluorescence, and polarization; Biology of cells and tissues; Tissue optical properties; Tissue-targeted contrast agents; Coherence and interference; Light transport in turbid media; Diagnostic applications of light, including microscopy, spectroscopy, fluorescence imaging, fluorescence-lifetime imaging, optical coherence tomography, diffuse optical tomography, and/or biosensors; Therapeutic applications of light, including photodynamic therapy, photothermal therapy, and/or laser ablation. Prerequisites: ECE 355, MATH 251, and PHYS 205B, or equivalent, with a grade of C or better, or consent of instructor. Students who are taking or have taken BME 431 or ECE 451 are ineligible to enroll. Credit Hours: 3. Credit Hours: 3

ECE507 - Image Sensors (Same as BME 507) Fundamentals of semiconductor physics, including the use of doping and biasing to control electronic potentials in devices; Fundamentals of integrated circuits, including the design and fabrication of diodes, transistors, and interconnects; Fundamental interactions between light and matter, including reflection, refraction, and absorption; Structure and operating modes of photodiodes; Architectures and operating principles for charge coupled device (CCD) image sensors and complementary metal-oxide-semiconductor (CMOS) image sensors; Performance metrics for image sensors, including the noise floor, the full-well capacity, the quantum efficiency, and fixed pattern noise; Construction of color image sensors; Signal processing for image sensors, including color interpolation and color correction. Prerequisite: ECE 355 and PHYS 205B, or equivalent, with a grade of C or better, or consent of instructor. Students who are taking or have taken BME 453 or ECE 453 are ineligible to enroll. Credit Hours: 3. Credit Hours: 3

ECE508 - Computer Systems Security Principles of computer systems security. Vulnerabilities, attacks and defenses, cryptographic primitives, authentication, digital signature, access control. Software systems security: buffer overflow, virus, SQL injection. Networking security: denial of service attack, firewall and IDS, Wi-fi security. Hardware systems security: secure processing and secure co-processor. Cloud, edge and IoT security. Students who have completed ECE 434 will not receive credit for this course. Restricted to graduate standing in ECE or consent of instructor. Credit Hours: 3

ECE509 - Systems Reliability Combinatorial aspects of system reliability. Parallel, standby, n-modular redundancy. Common cause failures. Information coding techniques. Reliability optimization and apportionment. Fault-tolerant computer design techniques. Students who have completed ECE 419 will not receive credit for this course. Restricted to graduate standing and consent of instructor. Credit Hours: 3

ECE510 - Hardware Designs and Architectures for AI Artificial intelligence (AI) is currently widely used in many advanced Machine learning (ML) applications. This course covers the fundamentals of design and implementation of hardware architectures for AI algorithms. Basic hardware building blocks will be introduced. It will also introduce the emerging memristor-crossbar array (MCA) as a computing platform for implementing neural network architectures. Students will gain hands-on experience through mixed-signal simulations and validation techniques. Students will be assigned a team project which applies concepts and tools learned from this course. Prerequisites: ECE 327 and ECE 345 with grades of C or better. Students who have completed ECE 410 will not receive credit for this course. Project-based fee: $35 to help defray cost of software licenses and computers in the lab. Credit Hours: 3

ECE511 - Software Hardware Co-design for Deep Neural Networks Analysis of deep learning techniques such as deep feedforward networks, regularization, optimization algorithms, convolutional networks, and sequence modeling. Utilization of machine learning frameworks such as Tensorflow and Pytorch. Investigation of hardware architectures for machine learning applications such as GPUs, TPUs, and systolic arrays. Students will also work on a semester-based project utilizing the latest advancements in deep neural networks. Students that have completed ECE 411 are not eligible to enroll in ECE 511 as the courses cover similar topics to an extent. Credit Hours: 3

ECE512 - Wireless Networks Compared to infrastructure based wireless communication systems, ad hoc wireless networks present several unique advantages. Thus, it has been widely studied as an important wireless communication paradigm. This graduate level course first introduces several widely adopted wireless communication technologies and then presents the concept, structure, and principles of ad hoc wireless networks. The course also introduces the details of several popular ad hoc wireless networks including mobile ad hoc networks, delay tolerant networks, wireless sensor networks, and connected vehicle networks. Novel applications in those networks will also be introduced. The course work will include paper and literature review, presentations, assignments, and a project that will enable students to be familiar with ad hoc wireless networks. NS2 will be used for student project in this course. Students can gain experience on NS2. Students who have taken ECE 412 are ineligible to enroll. Project-based fee: $10 to help defray cost of equipment. Credit Hours: 3

ECE513 - Digital VLSI Design Principles of the design and layout of Very Large Scale Integrated (VLSI) circuits concentrating on the CMOS technology. MOS transistor theory and the CMOS technology. Characterization and performance estimation of CMOS gates, CMOS gate and circuit design. Layout and simulation using CAD tools. CMOS design of datapath subsystems. Design of finite state machines. Examples of CMOS system designs. Laboratory experience in CMOS VLSI design. Restricted to enrollment in ECE program. Students who have taken ECE 423 are ineligible to enroll. Project-based fee: $35 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE514 - Design of Embedded Systems Introduction of modern embedded system application, platform architecture and software development. Principles of embedded processor architecture, operating systems and networking connectivity. Design and optimize in terms of system power, security and performance. Lecture and laboratory. Students who have taken ECE 424 will not receive credit for this course. Prerequisites: Courses equivalent to ECE 296, ECE 296L, ECE 321, ECE 329, with grades of C or better or consent of instructor. Lab fee: $10 to help defray cost of equipment. Credit Hours: 3

ECE515 - Three Dimensional Integration Systems This course introduces the design of three dimensional VLSI integration systems, including through-silicon-via (TSV) process, characterization and modeling, 3D IC systems design, mixed signal simulation, data management, testing, process, variation, thermal and reliability challenges, as well as review of 3D system design examples. Laboratory experience in design tools (Cadence Virtuoso and Liberate, AMS simulator). Prerequisite: ECE 345 and ECE 423 with a grade of C or better. Restricted to enrollment in ECE program. Credit Hours: 3

ECE516 - Implementation of VLSI Systems with HDL This course is dedicated for advanced Digital VLSI architecture and system implementation for high performance and low power digital signal processing applications. Application-specific processors and architectures to support real time processing of signal processing systems will be studied. Hands-on experience of using state-of-the-art CAD tools on designing such kind of VLSI architecture and systems. Upon completion of this course, students will entail large HDL-based implementation of a complete VLSI system. Students who have taken ECE 426 are ineligible to enroll. Prerequisite: ECE 327 with a grade of C or better. Project-based fee: $35 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE517 - Edge Computing Analysis of IoT architectures and core IoT modules, integration of sensors and data acquisition systems, power-aware optimizations, and embedded operating systems. Investigation of cloudlet topologies and services, edge to cloud protocols, and security. Special focus will be given on data analytics and machine learning in the cloud and the edge. Credit Hours: 3

ECE518 - Advanced Hardware Security and Trust Cryptographic systems and hardware. Advances in physically unclonable functions. Random number generators. Watermarking. Hardware metering. Side channel attacks including fault injection and power analysis. Types of hardware Trojan attacks (forms and sizes). Detection of hardware Trojans. Hardware tampering and obfuscation. Countermeasures against hardware attacks and hardware authentication. Counterfeit circuits: detection and avoidance. Trust issues in FPGAs. JTAG security and trust. SoC security requirements and secure design. Prerequisite: ECE 418 or graduate standing. Credit Hours: 3

ECE519 - Advanced Computer Security with Machine Learning This course covers the principles and practices of advanced computer systems security using machine learning. The principles encompass topics such as machine learning for computer security, cryptography, software and network security, as well as security and privacy in machine learning applications. The practical component consists of a series of hands-on labs aimed at achieving data confidentiality, authenticity, and integrity, along with exploring various attacks and their countermeasures. Restricted to graduate standing in ECE or consent of instructor. Credit Hours: 3

ECE520 - VLSI Design and Test Automation Principles of the automated synthesis, verification, testing and layout of Very Large Scale Integrated (VLSI) circuits concentrating on the CMOS technology. Resource allocation and scheduling in high-level synthesis. Automation of the logic synthesis for combinational and sequential logic. The physical design automation cycle and CMOS technology considerations. Fault modeling and testing. Timing analysis. Laboratory experience using commercial tools for synthesis and layout. Students who completed ECE 425 can't take ECE 520. They are similar. Prerequisite: ECE 327 with a C- or better or enrollment in ECE graduate programs. Project-based fee: $30 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE521 - Fault-Tolerant Computer Design Concepts of error detection, location and correction in digital systems. Codes for error detection and correction. Models and simulations of faults. Design of tests for combinatorial and sequential circuits. Testability. Design of digital systems with testability. Prerequisite: ECE 423, ECE 425 or consent of instructor. Restricted to enrollment in ECE program. Credit Hours: 3

ECE522 - VLSI Circuit Testing Theoretical and practical aspects of production testing of VLSI circuits. Relations between physical defects and fault models. Procedures for generating test inputs. Design modifications for test application and theory of built-in self-test. Prerequisite: ECE 425 or ECE 520 with a minimum grade of C or consent of instructor. Restricted to enrollment in ECE program. Project-based fee: $25 to help defray cost of software licenses. Credit Hours: 3

ECE523 - Low Power VLSI Design Source of power dissipation, technology impact on power dissipation, low power circuit techniques, energy recovery, synthesis of low power circuits, low power components. Prerequisite: ECE 423 or ECE 513 with a minimum grade of C or consent of instructor. Restricted to enrollment in ECE program. Project-based fee: $35 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE524 - Synthesis and Verification of Digital Circuits Binary decision diagrams, finite state machines and finite automata. Design automation concepts in logic level synthesis, optimization and verification for combinational as well as sequential logic. Technology mapping. Prerequisite: ECE 425 or ECE 520 with a minimum grade of C or consent of instructor. Restricted to enrollment in ECE program. Project-based fee: $35 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE525 - Advances in Physical Design Automation Advances in the automation of VLSI layouts with emphasis on recent developments in deep submicron, FPGA and MCM technologies. Floor planning, placement, routing objectives in high performance designs using deep submicron technology. Timing analysis in the presence of crosstalk. FPGA architectures and design with dynamically reconfigurable FPGAs. Physical design automation for MCMs. Prerequisite: ECE 425 or ECE 520 with a minimum grade of C or consent of instructor. Restricted to enrollment in ECE program. Project-based fee: $35 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE526 - Network Processing Systems Design Protocol processing, packet processing algorithms, classification and forwarding, queuing theory, switching fabrics, network processors, network systems design tradeoffs. Prerequisite: ECE 422 and ECE 429 or consent of the instructor. Restricted to enrollment in ECE program. Credit Hours: 3

ECE527 - Integrated Interconnection Networks Importance of interconnection networks and networks-on-chip (NOCs). Specifications and constraints. Topology, routing, flow control, deadlock, livelock, arbitration, allocation, performance analysis, simulation. Restricted to enrollment in ECE program. Credit Hours: 3

ECE528 - Programmable ASIC Design Principle and practice of designing and implementing Application-Specific Integrated Circuits (ASIC). Field Programmable Gate Arrays (FPGA). Timing analysis, timing closure and managing difference clock domains in ASIC design. Complex arithmetic circuits. Digital signal processing (DSP) circuits. FPGA microprocessors. Students who have taken ECE 428 are ineligible to enroll. Project-based fee: $50 to help defray cost of equipment and consumable items. Credit Hours: 3

ECE529 - Computer Systems Architecture Principles of performance evaluation, processor microarchitecture, instruction-level parallelism, static and dynamic pipeline considerations. Superscalar processors. Multiprocessor systems. Memory hierarchy design, cache design. Mutual exclusion and synchronization mechanisms. Students who have taken ECE 429 are ineligible to enroll. Restricted to enrollment in ECE program. Credit Hours: 3

ECE530 - Engineering Data Acquisition (Same as ENGR 530) Theory of data acquisition and measurement systems. Criteria for selection of data acquisition hardware and software, instruments, sensors and other components of scientific and engineering experimentation. Methods for sampled data acquisition, signal conditioning, interpretation, analysis and error estimation. Restricted to enrollment in ECE program. Project-based fee: $60 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE531 - Mixed-Signal VLSI Design Analysis and design of mixed-signal integrated circuits. Digital to analog converter (DAC). Analog to digital converter (ADC). Sigma-delta data converters. Performance analysis of signal chains containing both analog and digital signal processing functions. Prerequisite: ECE 446 with a minimum grade of C. Restricted enrollment in ECE program. Project-based fee: $60 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE532 - Programming Parallel Processors Multi-core architecture, threads, thread execution models, thread priority and scheduling, concurrency, multi-threaded programming models, synchronization, performance measurement and local balance, software tools for multi-threaded programming. Restricted to ECE students or consent of advisor. Students who have taken ECE 432 are ineligible to enroll. Project-based fee: $20 to help defray cost of equipment. Credit Hours: 3

ECE533 - Speech Processing (Same as BME 533) Fundamentals of speech production system, signal analysis of speech, speech coding, linear prediction analysis, speech synthesizing, and speech recognition algorithms. Students who have taken ECE 474 are ineligible to enroll. Prerequisite: MATH 250, ECE 355 with grades of C or better or consent of instructor. Credit Hours: 3

ECE534 - Biomedical Signal Analysis (Same as BME 536) The nature of biomedical signals. Electricity in living tissue. Biomedical signal processing and modeling. Modeling and simulation of biomedical systems. Prerequisite: MATH 250, ECE 355 with a grade of C or better or consent of instructor. Project-based fee: $20 to help defray cost of software licenses. Credit Hours: 3

ECE535 - CMOS Radio-Frequency Integrated Circuit Design Introduction of RF IC, passive RLC Networks, passive IC components, MOS Transistors, distributed systems, Smith Chart and S-Parameters, introduction to Band-width estimation, biasing and voltage reference, basic High Frequency Amplifiers, introduction to: noise in RF IC, Low Noise Amplifiers, Power Amplifiers, Phase-Locked Loops and Oscillators. Lecture and laboratory. Students who have taken ECE 440 are ineligible to enroll. Lab fee: $35 to defray the cost of software licenses and equipment. Credit Hours: 3

ECE536 - Embedded Systems Programming Advanced software concepts and techniques to develop complex software projects on embedded systems. Concepts and techniques include system calls,

structure of operating systems, advanced dynamic memory management, cross-compilation, scheduling techniques, and resource management. Students who have completed ECE 430 cannot take ECE 536. They are similar. Credit Hours: 3

ECE537 - Integrated Photonics Fundamentals of electromagnetic theory, waveguides, photonic structures including photonic crystals and integrated micro-ring resonator, numerical simulations of photonic integrated circuits using the beam propagation method, finite-difference time-domain method, rate equations, and fabrication processes. Prerequisite: ECE 441 or consent of instructor. Restricted to enrollment in ECE program. Credit Hours: 3

ECE538 - Medical Instrumentation: Application and Design (Same as BME 518) This course introduces ECE graduate students to the field of medical instrumentation. Medical instrumentation is the application of advanced engineering technology to problems in biology and medicine. The course focuses on fundamentals of instrumentation systems, sensors, amplifiers, and signal precondition. In addition, the course also includes design and applications of medical instrumentation, biopotential measurement, biomedical signal processing, and other related topics. Students who have completed ECE 438 or BME 438 will not receive credit for this course. Prerequisite: MATH 305 and ECE 355 with a grade of C or better, or consent of instructor. Restricted to enrollment in ECE programs. Project-based fee: $45 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE539 - Diagnostic Ultrasound Diagnostic ultrasound is an ultrasound-based medical imaging technique used to visualize muscles, tissue, and many internal organs, to capture their size, structure and any pathological lesions. This course is an introduction to the principles and applications of biomedical ultrasound. This course will focus on fundamentals of acoustic theory, principles of ultrasonic detection and imaging, design and use of currently available tools for performance evaluation of diagnostic devices, and biological effects of ultrasound. Students who have taken BME 439 or ECE 494 cannot receive credit for this course. Prerequisite: MATH 305 and ECE 355 or equivalent courses with a grade of C or consent of instructor. Restricted to enrollment in ECBE programs. Project-based fee: $30 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE540 - CMOS Radio-Frequency Integrated Circuit Design II High frequency amplifier design techniques, noise in RF IC and CMOS low noise amplifiers (LNA), mixers, oscillators, PLLs, frequency synthesizers, power amplifiers, an overview of wireless architectures. Prerequisite: ECE 440 or ECE 535 or equivalent. Lab fee: $50 to defray the cost of software licenses and equipment. Credit Hours: 3

ECE541 - Quantum Information Processing and Devices Fundamentals of information theory: uncertainty and information, thermodynamics of information. Quantum information processing: essential quantum mechanics of states, measurements and Bell's theorem, operations, and their representations as matrices; quantum Shannon theory (von Neumann entropy); quantum entanglement. Quantum cryptography. Various quantum algorithms and computational complexity. Building blocks: qubits and qubit operations, quantum machines. Decoherence, quantum error correction, and fault tolerance. Physical realization and quantum devices: double quantum dot charge qubit, Rabi oscillations of an excitonic qubit, Quantum dot spin-qubits, Photonic quantum computing, Superconducting qubits. Prerequisite: Familiarity with electronic and photonic devices, information theory, theoretical computer science, or quantum mechanics will be beneficial. Credit Hours: 3

ECE542 - Photonics and Devices Ray optics, wave optics, beam optics, polarization of light, Fourier optics, fiber optics, electro-optics, nonlinear optical media, acousto-optics, and photonic switching. Students who have completed ECE 441 cannot receive credit for this course. Prerequisite: ECE 375 (or equivalent) with a grade of C or better or consent of instructor. Project-based fee: $50 to help defray the cost of equipment and consumables. Credit Hours: 3

ECE543 - Advanced Analog Integrated Circuit Design Analysis and design of CMOS analog integrated circuits. Circuit noise analysis. Low-voltage high-performance operational amplifiers. Voltage and current reference circuits. Integrated analog filter circuits. Micropower circuits. Prerequisite: ECE 446 or ECE 546 with a minimum grade of C or consent of instructor. Restricted to enrollment in ECE program. Project-based fee: $35 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE543A - Bioelectronics and Biosensors (Same as BME 528) The sources of electrical signals in biological systems. Methods and types of sensors for sensing bioelectrical signals, including amperometric, potentiometric, piezo-electric, impedance, and FET based biosensors. Interface between

biosensors and electronics for sensor signal condition and data acquisition. Precision electronics for biosensor signal acquisition, including potentiostat, current, charge, capacitance and impedance sensing circuit, lock-in amplifier. Prerequisite: ECE 345 or equivalent with a grade of C or better. Students who have completed ECE 442 or BME 418 will not receive credit for this course. Credit Hours: 3. Credit Hours: 3

ECE544 - Optical Imaging and Photonics (Same as BME 544) Geometrical optics, including refraction and reflection; Physical optics, including interference, diffraction, and polarization; Optical aberrations, including causes and effects; Fourier optics, with applications to imaging; Light sources, including LEDs and lasers; Photodetectors, including photodiodes and image sensors; Lens systems; Microscopes. Students who are taking or have taken ECE 448 or BME 448 are ineligible to enroll. Prerequisites: ECE 355, MATH 251, and PHYS 205B, or equivalent, with a grade of C or better, or consent of instructor. Lab fee: $125 to help defray the cost of equipment, supplies, and software packages. Credit Hours: 3. Credit Hours: 3

ECE544A - Computer Vision This course covers fundamental and advanced topics in computer vision. Computer vision applications, image formation, image processing and filtering, deep learning, computer recognition and matching, 3D computer vision, motion and video. Students who have taken ECE 444 or BME 444 will not receive credit for this course. Prerequisite: ECE 355 with a minimum grade of C- or consent of instructor. Restricted to enrollment in ECE program. Credit Hours: 3. Credit Hours: 3

ECE545 - Advanced Semiconductor Devices Technology drivers: Moore, More-Moore, and More-than-Moore trends. Case Study: Integrated health monitoring systems, 3-D SoCs. Review of Solid-State Theory: electronic, magnetic, optical and thermal properties of semiconductors. Energy Related Devices: solid-state lighting, solar cells, thermoelectric devices, piezoelectric devices, energy storages and supercapacitors. Optoelectronic and Photonic Devices: Imagers, LEDs, OLEDs, Lasers, LCDs, thin-film transistors (TFTs). Sensors and Detectors. Microwave and Terahertz Devices. Prerequisite: ECE 447 or ECE 423 or ECE 446 or PHYS 425 or PHYS 430 or instructor consent. Credit Hours: 3

ECE545A - VLSI Design for Manufacturability and Process Control VLSI manufacturing: oxidation, photolithography, etching, doping; process integration and monitoring; Yield modeling. Design for manufacturability (DFM): Sources and impact of variability; Lithography aware design; Stress and related variations in FinFETs and beyond; Design solutions for analog systems, parametric fluctuations in digital systems, interconnects, compensation and limiting the degrees of freedom; Criticality-aware DFM. Process control: patterns, multivariate and supervisory control; Statistical experimental design; Process modeling and equipment diagnosis. Prerequisite: familiarity with physics of semiconductor devices (e.g., ECE 447 or ECE 423 or PHYS 425 with a grade of C or better, or instructor consent). Credit Hours: 3

ECE546 - Analog Circuit Design Analysis and design of electronic circuits, both discrete and integrated. Computer-aided circuit design and analysis. Design of amplifier and filter circuits. Circuit stability analysis and frequency compensation techniques. Restricted to enrollment in ECE program. Students who have taken ECE 446 are ineligible to enroll. Project-based fee: $10 to help defray cost of equipment. Credit Hours: 3

ECE547 - Semiconductor Devices Semiconductor industry and Moore's law. Review of quantum mechanics of atoms. From atoms to crystals: energy bands, effective mass and density-of-states. Semiconductor statistics. Carrier transport phenomena. PN junctions. Schottky junctions. Bipolar junction transistors (BJTs). MOSFETs: capacitance-voltage and current-voltage characteristics, threshold voltage, scaling and short-channel effects, SPICE models. CMOS process integration. Basic optoelectronic devices: LEDs and solar cells. Lecture and laboratory. Students who have taken ECE 447 are ineligible to enroll. Prerequisite: ECE 345 or equivalent. Project-based fee: $25 to help defray cost of software licenses. Credit Hours: 3

ECE548 - Quantum Phenomena and Devices Introduction: Classical Phenomena and Devices. Why Quantum Devices? Current Picture: Academia and Industry. Essential Statistical Mechanics. Essential Quantum Mechanics. Quantum Theory of Electrons: Quantization, Tunneling, Quantum Interference, Quantum Hall Effect, Scattering and Broadening, Dephasing and Shot Noise. Coulomb Blockade. Quantum Optics. Collective Phenomena and Spin. Relativistic Quantum Phenomena. Quantum Phase Transition. Quantum Computation. Prerequisite: ECE 447 or ECE 423 or ECE 446 or PHYS 425 or PHYS 430 with C or better or instructor consent. Credit Hours: 3

ECE549 - Fiber Optic Communications Fundamentals of step index and graded index fiber waveguides using geometrical optics and Maxwell's equations. Other topics include design criteria, practical coupling techniques, discussion of optical sources and detectors used in light-wave communications, system examples, characterization and measurement techniques. Prerequisite: ECE 447 or ECE 448 or consent of instructor. Restricted to enrollment in ECE program. Credit Hours: 3

ECE550 - Nanoscale VLSI Devices Review of fundamental principles of semiconductor devices. NanoTransistor: Charge-based devices-MOSFETs, non-ideal, atomistic, and quantum effects in nanoscale MOSFETs, charge-coupled devices. Advanced MOSFETs: FinFETs, SOI, SiGe and III-Vs, carbon nanotubes, graphene and 2-D semiconductors, nanowires. High electron mobility transistors (HEMTs), HBTs, and power MOSFETs. Compact and SPICE models for MOS devices. VLSI interconnects, parasitic elements, 3-D integration and reliability issues. Non-charge based devices-tunnel FETs, spin-based devices. NanoMemory: EEPROM and Flash, phase change memory, memristors, magnetic and ferroelectric, spin-torque devices, DRAM and ZRAM cells. TCAD simulation of semiconductor devices. Prerequisite: ECE 447 or ECE 423 or ECE 446 or PHYS 425 or PHYS 430 with a C or better or instructor consent. Project-based fee: $25 to help defray cost of software licenses. Credit Hours: 3

ECE551 - Probability and Stochastic Processes for Engineers Axioms of probability, random variables and vectors, joint distributions, correlation, conditional statistics, sequences of random variables, stochastic convergence, central limit theorem, stochastic processes, stationarity, ergodicity, spectral analysis, and Markov processes. Restricted to graduate student status. Students who have taken BME 351 or ECE 351 cannot receive credit for this course. Restricted to enrollment in ECBE. Project-based fee: $20 to help defray cost of software licenses. Credit Hours: 3

ECE552 - Signal Detection and Estimation Estimation theory: parameter estimation, minimum variance unbiased estimators, sufficient statistics, Cramer-Rao lower bound, best linear unbiased estimators, maximum likelihood estimators, least squares, Bayesian estimation, maximum a posteriori estimators, minimum mean square error estimators, linear minimum mean square error estimators, Wiener filtering. Detection theory: hypothesis testing, likelihood ratios, Neyman-Pearson detection, Bayesian hypothesis testing, matched filtering, multiple hypothesis testing, sequential detection, composite hypothesis testing, uniformly most powerful tests, generalized likelihood-ratio tests. Prerequisite: ECE 551 or consent of instructor. Restricted to enrollment in ECE program. Credit Hours: 3

ECE553 - Computer Network System Architecture Principles of Computer Networks. Protocols and system level implementations. Socket programming, router and switching fabric architecture, security and packet classification techniques, multimedia networking and QoS. Restricted to enrollment in ECE program. Students who have taken ECE 422 are ineligible to enroll. Project-based fee: $10 to help defray cost of equipment. Credit Hours: 3

ECE554 - Broadband Wireless Communications Statistical models for broadband wireless channels: angular, delay, Doppler and spatial domain characterizations, near/far-field propagation characteristics, spatial non-stationary propagation, and spatial wide-band fading. Broadband channel estimation, hybrid beamforming/detection and massive multi-antenna (MIMO) techniques. Millimeter-wave, terahertz, and holographic communication models. Reconfigurable/reflective intelligent surfaces and performance analysis. Broadband modulation multiple access techniques: index modulation, orthogonal time frequency space modulation, and orthogonal/non-orthogonal multiple access techniques. Prerequisites: ECE 315 and ECE 355 or consent of instructor. Restricted to EE or CEGR majors or consent of instructor. Credit Hours: 3

ECE555 - Introduction to Information Theory and Channel Coding Entropy and Mutual Information. Channel Capacity. Gaussian Channel. Linear Block Codes. Convolutional Codes. Advance Channel Coding Techniques. Students who have taken ECE 476 are ineligible to enroll. Restricted to enrollment in ECE program. Credit Hours: 3

ECE556 - Digital Communications Digital communication signals and systems characterization. Deterministic receiver design. Probabilistic receiver design. Error control coding. Communication over band limited channels. Prerequisite: ECE 551 or consent of the instructor. Restricted to enrollment in ECE program. Credit Hours: 3

ECE557 - Computational Electronics Elements of computational science/engineering. High-performance clusters and software tools for HPCs. Essential numerical methods. Review of solid-state theory. Fundamental physics of charge transport in semiconductor VLSI devices. Numerical solution of Poisson's and carrier continuity equations in semiconductor devices. Boltzmann transport equation and Monte Carlo solutions. Electronic bandstructure calculations using the tight-banding formalism. Introduction to NEGF formalism. Commercial and non-commercial semiconductor device modeling tools. Prerequisite: Familiarity with physics of semiconductor devices (e.g., ECE 447 or ECE 423 or PHYS 425 with a grade of C or better, or instructor consent). Project-based fee: $25 to help defray cost of software licenses. Credit Hours: 3

ECE558 - Digital Image Processing I Scope and applications of digital image processing, digital image fundamentals, intensity transformations and spatial filtering, filtering in the frequency domain, image segmentation, basics of color image processing. Students who have taken ECE 458 are ineligible to enroll. Prerequisite: ECE 355 with a minimum grade of C- or consent of instructor. Project-based fee: $30 to help defray cost of equipment. Credit Hours: 3. Credit Hours: 3

ECE559 - Reinforcement Learning A graduate level course on the theory and practice of Reinforcement Learning. The course covers topics such as finite and infinite horizon Markov decision processes, multi-armed bandit problem, dynamic programming, approximate dynamic programming, value and policy iteration, Q-learning, Monte Carlo methods, and stochastic approximation. Prior knowledge of machine learning and optimal control is helpful but not required. Credit Hours: 3

ECE559A - Biomedical Microelectromechanical Systems The course is designed to introduce students with fundamentals of MEMS and its applications. The emphasis will be on physical principle in sensors and corresponding fabrication techniques, with supplemental discussion of the state-of-art applications in industry and research. Students will learn to analyze and design systems by solving regular homework problems and active participation during lectures and in-class examples. Topics: Introduction of MEMS (Chapter 1), fundamentals of microfabrication and nanofabrication, fundamentals of physics in sensors, a case study of electrostatic sensing, microfluidics and biomedical applications, projects. Prerequisites: MATH 251, PHYS 205A, PHYS 205B each with a grade of C or better, or consent of instructor. Students who have completed BME 419 or ECE 459 will not receive credit for this course. Project-based fee: $50 to help defray cost of equipment and commodities. Credit Hours: 3

ECE560 - VLSI Material and Device Characterization Introduction to semiconductors. Materials for modern VLSI: crystals, tubular and monolayer materials, organic materials, heterostructures, wafers and notations. VLSI unit processes, contacts and interconnects, integration and packaging. Spontaneous formation and ordering of nanostructures. VLSI device characterization: wafer mapping, line width and contact resistance, measurement of MOS parameters, defect characterization using DLTS, carrier mobility and lifetime measurements. Optical characterization, electron beam microscopy, particle and X-ray techniques. Reliability and lifetime measurements: failure statistics and modes, hot carriers, NBTI, oxide integrity, electromigration and electrostatic discharge. Power dissipation and cooling. Prerequisite: Familiarity with physics of semiconductor devices (e.g., ECE 447 or ECE 423 or PHYS 425 with a grade of C or better, or instructor consent). Credit Hours: 3

ECE561 - Mechatronics and Embedded Control Components of mechatronics systems, mathematical modeling, system identification, numerical tools for design and analysis, single-loop controller design, embedded systems, data acquisition and signal conditioning, sensors, actuators, networked control. This course includes lab session. Students who have taken ECE 456 are ineligible to enroll. Lab fee: $35 to help defray the cost of software licenses. Credit Hours: 3

ECE562 - Microwave Engineering I Electromagnetic theory, analysis, design, fabrication, measurement and CAD applied to passive networks at microwave frequencies. Topics include: Transmission lines, Waveguides, Impedance matching, Tuning, Resonators, Scattering parameters, the Smith Chart. Lecture and Laboratory. Students who have taken ECE 479 are ineligible to enroll. Prerequisite: ECE 375 or equivalent. Restricted to enrollment in ECE program. Project-based fee: $100 to help defray cost of software licenses. Credit Hours: 3

ECE563 - Advanced Image Sensors Pixel- and system-level design of charge coupled device (CCD) and complementary metal-oxide-semiconductor (CMOS) image sensors; Image processing pipelines for CCD and/or CMOS image sensors; Sources of nonlinearity and non-uniformity in image sensors, including photodiodes and amplifiers; Sources of noise in image sensors, including photon shot noise,

dark shot noise, reset (kTC) noise, flicker (1/f) noise, and quantization noise; Materials used in image sensors, including silicon and indium gallium arsenide; Sources of resolution loss in image sensors, including crosstalk; Methods for evaluating image sensors; Technologies and techniques for moving beyond intensity-based imaging, including spectral imaging, polarization imaging, volumetric imaging, temporal imaging, and/or light-field imaging. Prerequisite: BME 453 or ECE 453 with a grade of C or better, or consent of instructor. Credit Hours: 3

ECE564 - Optimal Control Optimization techniques for linear and nonlinear systems. Variational calculus. Dynamic programming. Pontryagin's maximum principle. Hamilton-Jacobi theory. Linear regulator. Bang Bang control, minimum time control, singular control. Discrete variational calculus. Combined estimation and control. Computational methods in optimal control. Prerequisite: ECE 456 or consent of instructor. Restricted to enrollment in ECE program. Credit Hours: 3

ECE565 - Nonlinear Control Systems Analysis and design of nonlinear dynamical systems. Topics include: nonlinear differential equations, stability, Lyapunov stability analysis, stability of perturbed systems, linearization, and central manifold theorem. Stabilization, feedback linearization, and controller design methods such as backstepping and sliding mode control. Credit Hours: 3

ECE566 - Linear Systems Theory Introduction to the structure and analysis of linear dynamical systems in time domain. Linear algebra review, solutions of linear differential equations, state-space representations, state transition matrix, and time varying systems. Introduction to fundamental mathematics of linear spaces and linear operator theory. Structural properties of linear systems such as controllability, observability, and stability. Design and synthesis of controllers and state observers for linear systems. Linear quadratic regulatory theory and Kalman filter. Credit Hours: 3

ECE567 - Modern Biomedical Imaging (Same as BME 567) Diagnostic x-ray imaging. Tomographic imaging. Ultrasound imaging. Magnetic resonance imaging (MRI). Optical imaging. Signal and noise characteristics. Image quality evaluation. Three-dimensional image reconstruction algorithms. Students who have taken ECE 467 or BME 467 cannot receive credit for this course. Prerequisite: MATH 305 and ECE 355 with a grade of C- or better, or consent of instructor. Restricted to enrollment in ECE program. Project-based fee: $30 to help defray cost of software licenses and equipment. Credit Hours: 3. Credit Hours: 3

ECE568 - Introduction to Machine Learning for Engineering Applications Basic machine learning concepts: Model selection, feature scaling, bias-variance trade-off, regularization, Performance metrics and validation techniques, Probability and statistics review. Supervised learning: Linear/non-linear regression and logistic regression, Generalized linear models, Generative learning models, Bayes decision theory, Naive Bayes classifier, Nearest neighbor classifiers, Hidden-Markov models, Support vector machines, Kernel methods, Bagging, Boosting. Unsupervised Learning: Clustering: K-means, Expectation-maximization, Anomaly detection, Dimensionality Reduction: Principal components analysis, transform techniques. Basics of reinforcement learning and deep learning. Restricted to 4th Year or graduate standing. Students who have taken ECE 469 cannot receive credit for this course. They are similar. Credit Hours: 3

ECE568A - Digital Signal Processing This course introduces graduate students to the field of digital signal processing, which is an area of science and engineering that has developed rapidly. The course topics include discrete-time signals and systems analysis, z-transform, discrete Fourier transform, fast Fourier transform algorithms, digital filter design, and other related topics. Students who have completed ECE 468A will not receive credit for this course. Prerequisite: ECE 355 with a grade of C or better, or consent of instructor. Project-based fee: $20 to help defray cost of equipment. Credit Hours: 3

ECE569 - Biomedical Instrumentation (Same as BME 538) Basic concept of Medical instrumentation, basic sensors and principles, amplifiers, biopotential electrodes, blood pressure and sound, measurement of respiratory system, chemical biosensors, Cellular measurements, Nervous system measurements, magnetic resonance imaging. Prerequisites: PHSL 410A or CHEM 444 or consent of instructor. Restricted to enrollment in ECE program. Lab fee: $45 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE570 - Principles of Communication Systems This course covers principles of communication systems. Topics include representation of signals and systems, amplitude modulation, angle modulation, probability theory and random processes for communication system designs, transition from analog to

digital and pulse code/delta modulation, baseband digital transmission, digital band-pass transmission techniques, introduction to information theory and coding, wireless channel modeling, cellular systems and performance analysis. Lectures and laboratory projects. Prerequisites: ECE 315 and ECE 355 or consent of instructor. Students having passed ECE 478 are not eligible to enroll. Credit Hours: 3

ECE570A - Wireless Communication Systems This course covers fundamentals of wireless communication systems. Topics include wireless system architectures, channel modeling, introduction to cellular systems, digital modulation and multiple-access techniques, introduction to multiantenna techniques, performance analysis, wireless physical layer security, future trends in wireless communications. Prerequisites: ECE 315 and ECE 355 with a grade of C or better or consent of instructor. Students who have completed ECE 471 will not receive credit for this course. Project-based fee: $20 to help defray cost of software and equipment. Credit Hours: 3

ECE571 - Advanced Wireless Communication This course covers advanced topics in wireless communications. Topics include wireless system architectures, wireless channel modeling, cellular systems and co-channel interference, advanced digital modulation and multiple-access techniques, massive MIMO, mm-wave communications, performance analysis, radio resource allocation and optimization, wireless physical layer security, enabling technologies for 5G. Restricted to enrollment in ECE program or consent of instructor. Project-based fee: $20 to help defray cost of software licenses. Credit Hours: 3

ECE572 - Neural Networks (Same as BME 572) Anatomy and physiology of the cerebral cortex, Feed-forward Networks, Linear Associator, Multilayer Perceptrons, Feedback Networks, Hopfield Networks, ART. Applications to pattern recognition, robotics, image processing, and speech processing. Optical and electronic implementations. Students who have taken BME 470 or ECE 470 cannot receive credit for this course. Prerequisite: MATH 305 with a C or better or consent of instructor. Credit Hours: 3

ECE573 - Field and Waves II Time-harmonic electromagnetic fields in dielectric and lossy media, transmission lines, antennas and resonators. Techniques include duality, image theory, reciprocity and integral equations. Boundary value problems solved for several frequently encountered symmetries. Prerequisite: ECE 477. Restricted to enrollment in ECE program. Credit Hours: 3

ECE574 - Nonlinear Optics Coupled-mode-analysis applied to nonlinear wave interactions, harmonic generation, parametric amplification, backward wave amplifiers, backward oscillation in laser systems, phase conjugation and multiple-wave mixing systems, Pockel and Kerr effects, and electro-optical modulations in optical communication systems. Prerequisite: ECE 375 or consent of instructor. Restricted to enrollment in ECE program. Credit Hours: 3

ECE575 - Antennas I Analysis, design, fabrication, measurement and CAD applied to basic antenna types. Fundamental parameters. Friis transmission equation. Impedance and pattern measurements. Resonant microstrip and wire antennas. Arrays and line sources. Lecture and laboratory. Students who have taken ECE 472 are ineligible to enroll. Prerequisite: ECE 375 or equivalent. Restricted to enrollment in ECE program. Project-based fee: $120 to help defray cost of software licenses. Credit Hours: 3

ECE575A - Cyber Security for Digital Health This course introduces students to cyber security for digital health applications. Introduction to cyber security and cyber-attack surface, cyber security for electronic health records, cyber security for medical information, security and identity based on characteristics of face recognition and fingerprint recognition, cyber security for networked medical devices and healthcare facilities, cyber security for wearable or implantable devices. Students who have competed ECE 475 will not receive credit for this course. Prerequisite: MATH 251 with a minimum grade of C- or consent of instructor. Credit Hours: 3. Credit Hours: 3

ECE576 - Numerical Electromagnetics Numerical solution of electromagnetic problems by methods that include finite element, integral equation, moment, spectral domain and finite difference. Examination of electromagnetic problems and their solutions in current literature. Prerequisite: ECE 573. Restricted to enrollment in ECE program. Credit Hours: 3

ECE577 - Antennas II Analysis, design and CAD of antennas. Numerical methods. Broadband, traveling-wave, frequency independent, electrically-small, aperture and microstrip antenna types. Prerequisite: ECE 472. Restricted to enrollment in ECE program. Credit Hours: 3

ECE578 - Digital Image Processing II Full-color image processing, image noise and degradation models, image restoration, inverse filtering, Wiener filtering, geometric transformations, image compression models, error-free compression, lossy compression, compression standards, dilation and erosion, opening and closing operations, morphological filtering, boundary descriptors, regional descriptors, principal components, vision-based pattern recognition. Prerequisite: ECE 558. Restricted to enrollment in ECE program. Credit Hours: 3

ECE579 - Microwave Engineering II Analysis and design of passive and active devices at microwave frequencies. Topics include: power dividers, couplers, filters, ferrite devices, noise, noise effects in detectors, mixers, modulators, amplifier and oscillator design, and an introduction to microwave systems. Prerequisite: ECE 479. Restricted to enrollment in ECE program. Credit Hours: 3

ECE579A - Terahertz Devices and Applications THz band. Interaction of THz with matter, THz system components. Generation and detection of THz signals: photoconductive antenna, optical rectification, electro-optical sampling, quasi-phase-matching crystals, photo-mixers. Terahertz quantum cascade lasers: intersubband transitions, quantum dots photodetector, thermal detectors, device design and modeling. THz in 2D materials: Graphene and TMDs. Terahertz optics: metamaterials, photonic crystals, plasmonics. THz imaging: tomography, medical diagnostics. Spectroscopy: atoms, molecules, nanostructures. Nondestructive evaluation and security checks. THz wireless systems and THz in space. Prerequisite: familiarity with physics of semiconductor devices (e.g., ECE 447 or ECE 423 or PHYS 425 with a grade of C or better, or instructor consent). Credit Hours: 3

ECE580 - Seminar Study and formal presentation by students of selected research in electrical and computer engineering. Restricted to students in the graduate program in Electrical and Computer Engineering. Special approval needed from the instructor. Credit Hours: 1

ECE581 - Wind and Solar Energy Power Systems The course introduces students to wind and solar energy power systems. Planning of wind generation; and operation of wind generators, mechanical and electrical design, power conditioning, control and protection. Planning, operation and design of electric solar plants; power conditioning, control and protection. Students who have taken ECE 481 are ineligible to enroll. Credit Hours: 3

ECE582 - Power Electronics This course offers a comprehensive overview of power electronics devices and circuits, covering both foundational and advanced concepts. The primary objective is to equip students with design methodologies and analytical tools crucial for the efficient conditioning and management of electrical power. Topics include semiconductor power materials and devices, power converters, converter dynamics and control, switched mode power supply, and the use of machine learning for design optimization. Real-world applications in clean energy, electrification, electric vehicles, computing, display, and solid-state lighting will be covered. Fabrication and packaging of power electronics modules will also be discussed. Students will also engage in hands-on design projects using industry-standard TCAD software. Students who have received credit for ECE 482 will not receive credit for this course. Prerequisite: ECE 345 with a grade of C or better, or instructor consent. Project/design fee: $65 to help defray cost of software licenses. Credit Hours: 3

ECE583 - Electric Drive Systems Course content is roughly 1/3 power electronics, 1/3 applied control and 1/3 electric machinery and focuses on analysis, simulation, and control design of electric drive based speed, torque, and position control systems. Advanced topics depending on the semester are taught. Students who have taken ECE 483 are ineligible to enroll. Project-based fee: $65 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE584 - Electric and Hybrid Vehicles This course provides a comprehensive overview of modern all electric vehicles. It also touches on hybrid and plug-in hybrid vehicles. Topics include design analysis of vehicle components, trends in state-of-the-art power electronics materials, devices, and converters, battery and energy storage technologies, and the interaction of vehicles with the power grid. Key technical aspects with appropriate level of mathematical formulations and engineering design guidelines will be discussed. Essential features of autonomous driving system architecture and the associated hardware and software requirements will also be covered. Using industry-standard TCAD design software, students will work on a comprehensive design project or research paper on a topic of interest such as: i) emerging electric motors, ii) high-performance lithium ion batteries, iii) high-breakdown voltage power electronic converters. Students who have completed ECE 484 will not receive credit for this

course. Prerequisite: Familiarity with electronic devices and circuits and electric motors or instructor consent. Project/design fee: $65 to help defray cost of software licenses. Credit Hours: 3

ECE585 - Power Systems Stability and Control Fundamentals of power system stability, synchronous machine modeling and simulation, transient and small signal stability, control and protection, power system stabilizers, voltage stability, voltage collapse, concepts and devices of flexible ac transmission, mid-term and long-term stability. Credit Hours: 3

ECE586 - Computational Methods in Power Systems The course covers advanced methods for the computation and analysis of power systems. Topics: circuit graph theory and network matrices, computation of electromagnetic transients, computation of power flows and faults, computation of system stability, stochastic methods in power systems, load forecasting, state estimation, unit dispatch. The course uses power system software. Lecture. Restricted to enrollment in the ECE program. Credit Hours: 3

ECE586A - Clean Electric Energy History and future of energy resources and their use as a component of electrical systems. Fossil fuels and renewable energy sources. Environmental and economical impacts of various energy sources. Electric energy generating plants and distributed generation. Design of hybrid renewable energy systems. Students who have completed ECE 486 will not receive credit for this course. Prerequisite: ECE 385 with a grade of C or better, or consent of instructor. Credit Hours: 3. Credit Hours: 3

ECE587 - Modern Power Systems Operation This course provides students with a comprehensive picture of the techniques used in modern power systems operation. The course introduces central "terminal" characteristics for thermal and hydroelectric power generation systems, along with new optimization techniques for tackling "real-world" power systems operating problems. The topics include: analysis of different bidding strategies in competitive electricity markets, prediction of load and price, analysis of power systems security, different methods of optimal power flow, analysis of power systems uncertainty and reliability, economic dispatch, and unit commitment analysis. Project-based fee: $65 to help defray cost of software licenses and equipment. Credit Hours: 3

ECE587A - Power Systems Analysis Modeling and analysis of electric power systems. Topics covered: AC power, generators, power transformers, transmission line parameters and steady state operation, computation of power flows. The course uses power system analysis software. Students who have completed ECE 487 will not receive credit for this course. Prerequisite: ECE 385 with a grade of C or better, or consent of instructor. Credit Hours: 3. Credit Hours: 3

ECE588 - Power System Engineering The course covers topics involving the design and operation of a power system. Topics: symmetrical and unsymmetrical power system faults, power system protection design, transient stability of power generators, power system economic operation, power system control, transient operation of transmission lines. The course uses power system software. Lecture. Students who have taken ECE 488 are ineligible to enroll. Credit Hours: 3

ECE589 - Electric Power Distribution Design of primary and secondary distribution networks. Load characteristics. Voltage regulation. Metering techniques and systems. Protection of distribution systems. Special topics related to power distribution. Students who have taken ECE 489 are ineligible to enroll. Prerequisite: ECE 235. Credit Hours: 3

ECE592 - Special Investigations in Electrical Engineering Individual advanced projects and problems selected by student or instructor. Restricted to graduate standing. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593A - Advanced Topics in Electrical Engineering-Antennas and Propagation Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593B - Advanced Topics in Electrical Engineering-ASIC Design Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is

designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593C - Advanced Topics in Electrical Engineering-Communications Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593D - Advanced Topics in Electrical Engineering-Computer Architecture Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593E - Advanced Topics in Electrical Engineering-Control Systems Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593F - Advanced Topics in Electrical Engineering-Design Automation Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593G - Advanced Topics in Electrical Engineering-Digital Design Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593H - Advanced Topics in Electrical Engineering-Digital Testing and Verification Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593I - Advanced Topics in Electrical Engineering-Electromagnetic Fields and Waves Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593J - Advanced Topics in Electrical Engineering-Embedded Systems Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593K - Advanced Topics in Electrical Engineering-Medical Imaging Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593L - Advanced Topics in Electrical Engineering-Mixed-Signal Testing and Design Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593M - Advanced Topics in Electrical Engineering-Nanotechnology Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593N - Advanced Topics in Electrical Engineering-Network Systems Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course

is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593O - Advanced Topics in Electrical Engineering-Photonics Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593P - Advanced Topics in Electrical Engineering-Physical Design Automation Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593Q - Advanced Topics in Electrical Engineering-Power Electronic Converters and Drive Systems Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593R - Advanced Topics in Electrical Engineering-Power Quality Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593S - Advanced Topics in Electrical Engineering-Power System Control and Protection Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593T - Advanced Topics in Electrical Engineering-Renewable Energy Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593U - Advanced Topics in Electrical Engineering-RF and Microwave Systems Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593V - Advanced Topics in Electrical Engineering-Signal Processing Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593W - Advanced Topics in Electrical Engineering-Software Engineering Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE593X - Advanced Topics in Electrical Engineering-Wireless Systems Lectures on advanced topics of special interest to students in various areas of Electrical & Computer Engineering. This course is designed to offer and test new experimental courses in ECE. Restricted to enrollment in ECE program. Special approval needed from the instructor. Credit Hours: 1-3

ECE595 - Communication Skills for Engineering Graduate Students This course prepares graduate engineering students to communicate technical information to various audiences and for various purposes. Principles and strategies are applied to theses, dissertations, scholarly presentations, and other engineering documents such as lab reports, user manuals, business correspondences, job application materials, and engineering ethics. Research tools and software programs prepare students to deliver oral presentations on current engineering topics. Restricted to graduate standing. Does not count toward the hours required for graduation in the ECE program. Restricted to enrollment in ECE program. Credit Hours: 3

ECE596 - Principles of Biomedical Engineering (Same as BME 596) Principles of biomechanics, biomaterials, electrophysiology, modeling, instrumentation, biosignal processing, medical imaging, and biomedical optics. Professional moral and ethical issues in biomedical research and development. Students who have taken ECE 460 are ineligible to enroll. Prerequisite: MATH 250 with a grade of C or better or consent of instructor. Credit Hours: 3

ECE599 - Thesis Credit Hours: 1-6

ECE600 - Doctoral Dissertation Dissertation research. Hours and credit to be arranged by director of graduate studies. Graded S/U only. Restricted to Admission to PhD program in Electrical and Computer Engineering. Credit Hours: 1-16

ECE601 - Continuing Enrollment For those graduate students who have not finished their degree programs and who are in the process of working on their dissertation, thesis, or research paper. The student must have completed a minimum of 24 hours of dissertation research, or the minimum thesis, or research hours before being eligible to register for this course. Concurrent enrollment in any other course is not permitted. Graded S/U or DEF only. Credit Hours: 1

Electrical and Computer Engineering Faculty

Ahmed, Shaikh S., Professor, Ph.D., Arizona, 2005; 2007. Nanotechnology, semiconductor devices and circuit design, simulation and characterization.

Anagnostopoulos, Iraklis, Associate Professor, Ph.D., National Technical University of Athens, 2014; 2015. Many-core architectures, run-time resource management, embedded systems.

Aruma Baduge, Gayan, Associate Professor, University of Alberta, 2013; 2016. Communications theory, wireless communications, massive MIMO systems, millimeter-wave communications, cooperative relay networks, wireless energy harvesting for IoTs, physical-layer security.

Asrari, Arash, Assistant Professor, Ph.D., University of Central Florida, 2015; 2017. Power systems operation and planning, power systems optimization, smart grid.

Chen, Kang, Associate Professor, Ph.D., Clemson University, 2014; 2015. Software-defined networking (SDN), network function virtualization (NFV), vehicular networks, mobile opportunistic/ad hoc networks.

Chen, Ying (Ada), Associate Professor, Ph.D., Duke, 2007; 2007. Biomedical imaging, image reconstruction, digital tomosynthesis, image quality analysis, signal and image processing, simulation and computing.

Chilman, Bae, Assistant Professor, Ph.D., Pennsylvania State University, 2009; 2019. Bioelectrical engineering, neuroscience, mechanobiology.

Chowdhury, Farhan, Associate Professor, Ph.D., University of Illinois at Urbana-Champaign, 2011; 2015. Mechanobiology, single-molecule cell mechanics, biomaterials.

Haniotakis, Themistoklis, Associate Professor, Ph.D., University of Athens, 2008; 2013. Digital VLSI design and test, RF IC design and test, low power VLSI design, and fault-tolerant systems.

Kagaris, Dimitrios, Professor, Ph.D., Dartmouth College, 1994; 1995. VLSI design automation, digital circuit testing, communications networks, biostatistics, bioinformatics.

Komaee, Arash, Associate Professor, Ph.D., University of Maryland, College Park, 2008; 2015. Control systems, microrobotics, signal processing, estimation theory.

Lu, Chao, Associate Professor, Ph.D., Purdue University, 2012; 2015. VLSI system design, device-circuit co-design, 3D IC.

Qin, Jun, Associate Professor, Ph.D., Duke University, 2008; 2012. Sensors and instrumentation, data acquisition, medical devices, therapeutic ultrasound, haptics.

Sayeh, Mohammad R., Professor, Ph.D., Oklahoma State University, 1985; 1986. Neural networks, optical computing, image processing, stochastic modeling, quantum electronics.

Tragoudas, Spyros, Professor and Director, Ph.D., University of Texas at Dallas, 1991; 1999. Design and test automation for VLSI, embedded systems, computer networks.

Wang, Haibo, Professor, Ph.D., University of Arizona, 2002; 2002. Bioelectronics, biosensors.

Weng, Ning, Professor, Ph.D., University of Massachusetts at Amherst, 2005; 2005. High performance routers, network processors, system-on-a-chip, computer architectures.

Emeriti Faculty

Botros, Nazeih M., Professor, Emeritus, Ph.D., University of Oklahoma, 1985; 1985.

Daneshdoost, Morteza, Professor, Emeritus, Ph.D., Drexel University, 1984; 1984.

Galanos, Glafkos D., Professor, Emeritus, Ph.D., University of Manchester, England, 1970; 1987.

Gupta, Lalit, Professor, Emeritus, Ph.D., Southern Methodist University, 1986; 1986

Hatziadoniu, Konstantine, Professor, Emeritus, Ph.D., West Virginia University, 1987; 1987.

Osborne, William, Professor, Emeritus, Ph.D., New Mexico State University, 1970; 2005.

Pourboghrat, Farzad, Professor, Emeritus, Ph.D., University of Iowa, 1984; 1984.

Viswanathan, Ramanarayanan, Professor, Emeritus, Ph.D., Southern Methodist University, 1983; 1983.

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