

Department of Electrical and Computer Engineering

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Interim Chair:
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The Department of Electrical and Computer Engineering offers academic programs in advanced study to graduates with technical background in preparation for careers in industry and in academic research. In addition to the doctoral and master's degrees, which are granted in recognition of research contribution and course work, the department offers a number of professional master's degrees and certificate programs to enable practicing engineers to pursue continuing education in their areas of interest.

Faculty members are engaged in research in the forefront of their fields, with funding derived from industrial and government research grants and contracts, which provide support to graduate students in the form of research assistantships, in addition to the development and the maintenance of the research facilities. The department also offers a number of fellowships and teaching assistantships on a competitive basis.

Admission to graduate study in one of the programs requires the completion of an undergraduate degree or its equivalent in electrical engineering, computer engineering, or other engineering disciplines from an accredited university. Individuals with a background in other fields of engineering are required to complete courses in the core undergraduate curriculum before commencing graduate work.

For many years, the graduate programs offered by the department have facilitated the professionals in industry to advance their knowledge through the pursuit of graduate degrees. IIT Online, the interactive distance learning facility of IIT, provides support to continuing education by making numerous courses accessible via the Internet and a regional multi-channel television network serving over 50 industrial organizations in the metropolitan Chicago area.

Degrees Offered

Master of Science in Electrical Engineering
Master of Science in Computer Engineering
Master of Science in Computer Engineering and
Electrical Engineering (dual degree)
Master of Electrical and Computer Engineering
Master of Biomedical Imaging and Signals

Master of Power Engineering
Master of VLSI and Microelectronics
Master of Network Engineering
Doctor of Philosophy in Electrical Engineering
Doctor of Philosophy in Computer Engineering

Joint Degree Programs

With the Department of Computer Science:
Master of Telecommunications and Software Engineering

With Center for Financial Markets:
Master of Electricity Markets

Certificate Programs

Advanced Electronics
Applied Electromagnetics
Communication Systems
Computer Engineering
Control Systems

Electricity Markets
Power Electronics
Power Engineering
Signal Processing
Wireless Communications Engineering

Interdisciplinary Programs

Master of Science in Electrical Engineering with specialization in Energy/Environment/Economics (E³)

Research Centers and Facilities

The department operates research laboratories for work in CAD for VLSI and SoC design, communications, computer networking, embedded computing, image processing and medical imaging, microwave electronics, power systems, signal processing and ultrasonic imaging. The Electric Power and Power Electronics Center supports research initiatives with support from industry and government in the areas of power systems, power electronics, electric machines, motor drives, and vehicular power systems. The department also collaborates with and utilizes the research resources of the Pritzker Institute of Biomedical Science and Engineering and nearby national laboratories.

The department has state-of-the-art computer systems to enhance and extend the generally available system in the university. A primary resource is a network of more than 100 high-performance workstations, file

servers, and computer servers, running the Unix/Linux operating system. With mass storage, CD-ROM drives, tape drives, and accelerated graphics, these systems provide students and researchers with an array of software tools including: programming languages (C, C++, Java, FORTRAN, Python, Perl, etc.), software development tools, software and hardware simulators, and electronic computer-aided design packages from companies such as Cadence, Synopsys, Avanti, Synplicity, Xilinx, Altera, Mentor Graphics, EPRI, and ESCA.

In addition to the workstations, the department maintains a collection of PCs for ECE students, including a set of machines that can be dedicated to hardware/software projects. The computers are connected via high-speed Ethernet, which in turn is connected to the university's backbone and the Internet.

Research Areas

Active research programs are conducted in the general areas of communication systems; computer systems

and micro-electronics; electromagnetics and electronics; power and control systems; signal and image processing.

Faculty

Mark Anastasio, Associate Professor. B.S., Illinois Institute of Technology; M.S.E., University of Pennsylvania; Ph.D., University of Chicago. Tomographic reconstruction algorithm, numerical analysis of inverse problem in biomedical imaging, theoretical imaging science.

Tricha Anjali, Assistant Professor. M. Tech. in Electrical Engineering, Indian Institute of Technology; Ph.D., Georgia Institute of Technology. Broadband networks, adaptive network management and optical networks.

Robert Arzbaecher, Emeritus Professor. Ph.D., University of Illinois, Urbana-Champaign, Instrumentation, signal processing and control.

Guillermo E. Atkin, Associate Professor. B.S., Universidad F. Santa Maria (Chile); Ph.D., University of Waterloo (Canada). Modulation and coding, digital mobile and wireless communication, spread spectrum and optical communication systems.

Suresh Borkar, Senior Lecturer. B. Tech (EE) Indian Institute of Technology (India); MS and Ph.D., Illinois Institute of Technology, Wireless and wireline telecommunications, operating systems, architecture, and performance of computer and network systems.

Jovan G. Brankov, Research Assistant Professor. Dipl. Ing., Electrical Engineering, University of Belgrade; M.Sc., Ph.D., Illinois Institute of Technology. Medical imaging, image sequence processing, pattern recognition and data mining.

Yu Cheng, Assistant Professor. B.E. and M.E., Tsinghua University (China); Ph.D. the University of Waterloo (Canada), Computer network management, Internet measurement, performance analysis, and quality of service provisioning, wireless networks, and wireless/wireline interworking.

Ken Choi, Assistant Professor, B.S., M.S., Kyung Hee University (Korea); Ph.D., Georgia Institute of Technology. VLSI design and automation for low power.

Ali Emadi, Professor, B.S., M.S., Sharif University of Technology (Iran); Ph.D., Texas A&M University. Power electronics, motor drives, electric machines, vehicular power systems.

Alexander J. Flueck, Associate Professor. B.S., M.E., Ph.D., Cornell University. Power systems, computational methods, control systems.

Alireza Khaligh, Assistant Professor. B.S., M.S., Sharif University (Iran); Ph.D., Illinois Institute of Technology. Power electronics, energy systems, energy scavenging, and design of energy-efficient power supplies.

Joohee Kim, Assistant Professor. B.S., M.S., Yonsei University (Korea); Ph.D., Georgia Institute of Technology. Image/video signal processing and coding for multimedia networking.

Mahesh Kirshnamurthy, Assistant Professor. B.S., Amravati University (India); M.S., University of Missouri- Rolla; Ph.D., University of Texas-Arlington. Embedded systems for renewable energy and vehicular applications and power electronics for vehicular applications.

Zuyi Li, Assistant Professor. B.S. (EE), Shanghai Jiaotong University (China); M.S., Tsinghua University (China); Ph.D., Illinois Institute of Technology. Market operation of electric power system, security-constrained unit commitment, arbitrage in electricity market, market power analysis and risk management, ancillary services auction, transmission pricing.

Erdal Oruklu, Assistant Professor. B.S., Technical University of Istanbul (Turkey); M.S., Bogazici University (Turkey); Ph.D., Illinois Institute of Technology. VLSI and SoC design, signal processing architectures, digital arithmetic, computer systems.

Kui Ren, Assistant Professor. B.S., M.S., Zhejiang University (China); Ph.D., Worcester Polytechnic Institute. Network security, wireless networks, Internet security, information assurance, and applied cryptography.

Gerald F. Saletta, Emeritus Professor. B.S., M.S., University of Notre Dame; Ph.D., Illinois Institute of Technology. Electronics, digital systems.

Jafar Sanjii, Filmer Professor, Associate Chair, Graduate Program Director, and Computer Engineering Director. B.S., University of Maryland; M.S., Case Western Reserve University; Ph.D., Purdue University. Embedded computing, DSP architectures, signal and image processing, detection and estimation, ultrasonic imaging for both medical and industrial applications.

Mohammad Shahidehpour, Carl and Paul Bodine Professor, and Department Chair. B.S., Arya-Mehr University of Technology (Iran); M.S., Ph.D., University of Missouri, Columbia. Large-scale power systems, nonlinear stochastic systems, optimization theory.

Hassan Shanechi, Senior Lecturer. B.S., M.S., Tehran University (Iran); Ph.D., Michigan State University. Nonlinear and intelligent systems, power system dynamics and security.

Henry Stark, Emeritus Professor. B.E.E., City College of New York; M.S., D.Eng.Sc., Columbia University. Image reconstruction, medical imaging, pattern recognition, signal processing and sampling theory, optics.

Jia Wang, Assistant Professor. B.S., Tsinghua University (China); M.S., Ph.D., Northwestern University. VLSI, design automation, and algorithm design.

Erwin W. Weber, Emeritus Professor, B.S., M.S., Ph.D., Illinois Institute of Technology, Electromagnetics, RF electronics, antenna theory.

Miles Wernick, Professor and Director of Medical Imaging. B.A., Northwestern University; Ph.D., University of Rochester. Medical imaging, image processing, pattern recognition.

Geoffrey Williamson, Professor. B.S., M.S., Ph.D., Cornell University. Adaptive filtering, signal processing and control, parameter estimation and system identification, control systems, robust control theory.

Thomas T. Y. Wong, Professor. B.S., University of Hong Kong; M.S., Ph.D., Northwestern University. Microwave communications systems, nonlinear device measurement, semiconductor device theory, microwave electronics and instrumentation.

Yongyi Yang, Professor. B.S., M.S., Northern Jiatong University (China); M.S., Ph.D., Illinois Institute of Technology. Image and signal processing, data compression, applied mathematical and statistical methods.

Yang Xu, Assistant Professor. B.S., M.S., Fudan University (China); Ph.D., Carnegie Mellon University. RFIC design for digital communications and wireless medical technology.

Imam Samil Yetik, Assistant Professor. B.S., Bogazici University (Turkey), M.S., Bilkent University (Turkey), Ph.D., University of Illinois at Chicago, Statistical signal and image processing with applications to biomedicine.

Chi Zhou, Assistant Professor. B.S., Tsinghua University (China), M.S. and Ph.D., Northwestern University, Resource allocation and power control for multimedia cellular networks, integration of 3G, WLAN, WiMAX and SONET, sensor networks, jamming avoidance over OFDM or MIMO systems.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0 GRE minimum score:

M.S./MAS: 1100 (quantitative + verbal) 3.5 (analytical writing)

Ph.D.: 1100 (quantitative + verbal) 3.5 (analytical writing)

TOEFL minimum score: 550/213/80*

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered. Professional Master's degrees in electrical and computer engineering, network engineering, telecommunication and software engineering, and electricity markets do not require GRE scores for applicants who hold undergraduate degrees from universities in the United States with a minimum cumulative GPA of 3.0/4.0.

Admission to the master's degree programs normally requires a bachelor's degree from an accredited institution in electrical engineering or computer engineering. Applicants with backgrounds in other fields with proficiency in engineering sciences, physics, mathematics or computer science, gained through prior coursework or professional experience, are also eligible for admission,

but will be required to demonstrate proficiency in the subject matter covered in undergraduate courses that are prerequisites for the chosen graduate program.

Proficiency may be demonstrated by passing a written exam or by taking and passing, with a grade of B or better, prerequisite undergraduate courses at IIT. Specific course prerequisites for each degree program are listed within the program description.

Admission to the doctoral program requires a master's degree. Each entering degree-seeking graduate student is assigned a temporary academic adviser who will provide initial guidance to the candidate. As their research and other academic interests become defined, students may opt to select a new permanent advisor.

Non-degree graduate students should consult with the department advisor. Students are responsible for following the guidelines of the graduate programs set by the department, in conjunction with the regulations of the Graduate College.

*Paper-based test score/computer-based test score/internet-based test score.

Master of Science in Electrical Engineering

32 credit hours
Thesis option

The purpose of this degree is to prepare students for advanced study and/or research and industry in the field of electrical engineering. The Master of Science in Electrical Engineering (M.S.E.E.) is a degree program combining breadth across several areas of study within electrical engineering and specialization within one area, which includes an option to pursue thesis research under the guidance of a faculty advisor. Areas of study include communication and signal processing; computers and microelectronics; and power and control systems. The program is normally completed in three semesters of full-time study.

Students whose accredited B.S. degree is not in electrical engineering may pursue the M.S.E.E. provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to IIT's ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 307 (Electrodynamics), ECE 308 (Signals and Systems), ECE 311 (Engineering Electronics), MATH 251 (Multivariate and Vector Calculus), and MATH 252 (Introduction to Differential Equations).

A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department. The program of study includes a minimum of 32 credit hours of acceptable graduate coursework, with a minimum of 20 credit hours of ECE courses at the 500-level or higher. Up to six credits of ECE short courses may be applied to the degree.

Students, with their advisor, select courses appropriate to their needs and interests. The program of study must include four courses within one of the electrical engineering (EE) areas of concentration listed below and one course from each of the two remaining areas. An M.S.E.E. candidate may, with permission of a thesis advisor, include in his or her program a thesis of six to eight credit hours. The master's thesis is recommended for pre-doctoral students. The thesis option requires a written thesis and an oral defense of the thesis. Thesis format and deadlines are set by the Graduate College.

M.S. in Electrical Engineering Areas of Concentration

I. Communications and Signal Processing

- ECE 401 Communication Electronics
- ECE 403 Digital and Data Communication Systems
- ECE 405 Digital and Data Communication Systems with Laboratory
- ECE 421 Microwave Circuits and Systems
- ECE 423 Microwave Circuits and Systems with Laboratory
- ECE 436 Digital Signal Processing I with Laboratory
- ECE 437 Digital Signal Processing I
- ECE 481 Image Processing
- ECE 504 Wireless Communication System Design
- ECE 507 Imaging Theory and Applications
- ECE 508 Video Communications
- ECE 509 Electromagnetic Field Theory
- ECE 511 Analysis of Random Signals
- ECE 513 Communication Engineering Fundamentals
- ECE 514 Digital Communication Principles
- ECE 515 Modern Digital Communications
- ECE 519 Coding for Reliable Communications
- ECE 522 Electromagnetic Compatibility
- ECE 565 Computer Vision and Image Processing
- ECE 566 Statistical Pattern Recognition
- ECE 567 Statistical Signal Processing
- ECE 568 Digital Speech Processing
- ECE 569 Digital Signal Processing II
- ECE 570 Fiber Optic Communication Systems
- ECE 576 Antenna Theory
- ECE 578 Microwave Theory

II. Computers and Microelectronics

- ECE 407 Introduction to Computer Networks with Laboratory
- ECE 408 Introduction to Computer Networks
- ECE 415 Solid-State Electronics
- ECE 425 Analysis and Design of Integrated Circuits
- ECE 429 Introduction to VLSI Design
- ECE 441 Microcomputers
- ECE 446 Advanced Logic Design
- ECE 449 Object-Oriented Programming and Computer Simulation
- ECE 485 Computer Organization and Design
- ECE 502 Basic Network Theory
- ECE 521 Quantum Electronics
- ECE 524 Advanced Electronic Circuit Design
- ECE 525 RF Integrated Circuit Design
- ECE 526 Active Filter Design
- ECE 527 Performance Analysis of RF Integrated Circuits
- ECE 529 Advanced VLSI Systems Design
- ECE 530 High Performance VLSI/IC Systems
- ECE 541 Performance Evaluations of Computer Networks

- ECE 542 Design and Optimization of Computer Networks
- ECE 543 Computer Network Security
- ECE 544 Wireless and Mobile Networks
- ECE 545 Advanced Computer Networks
- ECE 546 Wireless Network Security
- ECE 571 Nanodevices and Technology
- ECE 575 Electron Devices
- ECE 583 High Speed Computer Arithmetic
- ECE 584 VLSI Architectures for Signal Processing and Communications
- ECE 585 Advanced Computer Architecture
- ECE 586 Fault Detection in Digital Circuits
- ECE 587 Hardware/Software Codesign
- ECE 588 CAD Techniques for VLSI Design
- ECE 589 Computer-Aided Design of Analog IC

III. Power and Control

- ECE 411 Power Electronics
- ECE 412 Electric Motor Drives
- ECE 417 Power Distribution Engineering
- ECE 418 Power Systems Analysis
- ECE 419 Power Systems Analysis with Laboratory
- ECE 420 Analytical Methods in Power Systems
- ECE 438 Control Systems
- ECE 505 Applied Optimization for Engineers
- ECE 506 Analysis of Nonlinear Systems
- ECE 531 Linear System Theory
- ECE 535 Discrete Time Systems
- ECE 538 Renewable Energies
- ECE 539 Computer Aided Design of Electric Machines
- ECE 540 Reliability Theory and System Implementation
- ECE 548 Energy Harvesting
- ECE 549 Motion Control Systems Dynamics
- ECE 550 Power Electronic Dynamics and Control
- ECE 551 Advanced Power Electronics
- ECE 552 Adjustable Speed Drives
- ECE 553 Power System Planning
- ECE 554 Power Systems Relaying
- ECE 555 Power Market Operations
- ECE 556 Power Market Economics and Security
- ECE 557 Fault-Tolerant Power Systems
- ECE 558 Power System Reliability
- ECE 559 High-Voltage Power Transmission
- ECE 560 Power Systems Dynamics and Stability
- ECE 561 Deregulated Power Systems
- ECE 562 Power System Transaction Management
- ECE 563 Computational Intelligence in Engineering
- ECE 564 Control and Operation of Electric Power Systems
- ECE 580 Elements of Sustainable Energy
- ECE 581 Elements of Smart Grid

Master of Science in Computer Engineering

32 credit hours
Thesis option

The purpose of this degree is to prepare students for advanced study and/or research and industry in the field of computer engineering. The Master of Science in Computer Engineering (M.S.CP.E.) program builds a strong foundation in all aspects of the design and development of computer systems, with a specialization in a major area. Students have the option to pursue thesis research under the guidance of a faculty advisor. Areas of study include computer hardware design, computer networking and telecommunications, and computer system and application software. The program is normally completed in three semesters of full-time study. Students whose accredited B.S. degree is not in computer engineering may pursue the M.S.CP.E., provided that they have an adequate background and can demonstrate proficiency in the material contained in the following undergraduate courses: ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 242 or CS 350 (Digital Computers and Computing), ECE 311 (Engineering Electronics), CS 201 (i.e., CS 115 and CS 116 combined, Object Oriented Programming I-II), CS 401 (Introduction to Advanced Studies in CS), and MATH 252 (Introduction to Differential Equations). A student

may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department.

The program of study includes a minimum of 32 credit hours of acceptable graduate coursework, with a minimum of 21 credit hours of ECE coursework. A minimum of 20 credit hours must be taken at the 500-level or higher excluding short courses and Master's Seminar. Up to two credits of master's seminar (ECE 595 or ECE 596), and up to six credits of ECE short courses may be applied to the degree. Students, in consultation with their advisor, select courses appropriate to their needs and interests. The program of study must include two core and two elective courses within one of the following computer engineering (CPE) areas of concentration, and at least one core course from the remaining two areas.

An M.S.CP.E candidate may, with permission of a thesis advisor, include in his or her program a thesis of six to eight credit hours. The master's thesis is strongly recommended for pre-doctoral students. The thesis option requires a written thesis and an oral defense of the thesis. Thesis format and deadlines are set by the Graduate College.

M.S. in Computer Engineering Areas of Concentration and Curriculum

Computer Hardware Design

Core courses

ECE 529 Advanced VLSI Systems Design

AND/OR

ECE 429 Introduction to VLSI Design

AND

ECE 585 Advanced Computer Architecture

Elective courses

ECE 425 Analysis and Design of Integrated Circuits

ECE 441 Microcomputers

ECE 446 Advanced Logic Design

ECE 485 Computer Organization and Design

ECE 530 High Performance VLSI/IC Systems

ECE 583 High Speed Computer Arithmetic

ECE 584 VLSI Architectures for Signal Processing and Communications

ECE 585 Advanced Computer Architecture

ECE 586 Fault Detection in Digital Circuits

ECE 587 Hardware/Software Codesign

ECE 588 CAD Techniques for VLSI Design

Computer Systems Software

Core courses

CS 550 Comparative Operating Systems

CS 551 Operating System Design and Implementation

Elective courses

ECE 449 Object-Oriented Programming and Computer Simulation

ECE 587 Hardware/Software Codesign

CS 487 Software Engineering I

CS 545 Distributed Computing Landscape

CS 546 Parallel and Distributed Processing

CS 555 Analytic Models and Simulation of Computer Systems

CS 586 Software Systems Architectures

CS 587 Software Project Management

CS 588 Advanced Software Engineering Development

CS 589 Software Testing and Analysis

Networks and Telecommunications

Core courses

ECE 407 Introduction to Computer Networks with Laboratory **OR**

ECE 408 Introduction to Computer Networks

ECE 545 Advanced Computer Networks

AND

ECE 541 Performance Evaluation of Computer Networks

AND/OR

ECE 542 Design and Optimization of Computer Networks

Elective courses

ECE 504 Wireless Communication System Design

ECE 508 Video Communications

ECE 511 Analysis of Random Signals

ECE 513 Communication Engineering Fundamentals

ECE 514 Digital Communication Principles

ECE 515 Modern Digital Communications

ECE 519 Coding for Reliable Communications

ECE 543 Computer Network Security

ECE 544 Wireless and Mobile Networks

ECE 546 Wireless Network Security

ECE 570 Fiber Optic Communication Systems

ECE 584 VLSI Architectures for Signal Processing and Communications

CS 455 Data Communications

CS 544 Computer Networks II: Network Services

Master of Science in Computer Engineering and Electrical Engineering

dual degree
30 credit hours
Thesis option

The purpose of the Master of Science in Computer Engineering and Electrical Engineering (M.S.CP.E./E.E.) is to prepare students for advanced study and/or research, or for industry in the field of both computer and electrical engineering. The M.S.CP.E./E.E. program provides for a strong foundation in all aspects of the design and development of computer systems, and also offers several areas of study within electrical engineering. There is also an option to pursue thesis research under the guidance of a faculty advisor.

There is a growing need for engineers with a strong educational background in both computer engineering and electrical engineering. In the M.S.CP.E./E.E. program students will be introduced to topics important to the computer engineering field such as computer hardware design, computer networks and software engineering, as well as topics in electrical engineering such as communications and signal processing, electronics and electromagnetics, and power and control systems. The program of study includes a minimum of 45 credit hours of acceptable graduate coursework in both computer engineering and electrical engineering. M.S.CP.E./E.E. degree requirements are described in the section below. Requirements for the M.S.CP.E./E.E. fully satisfy the existing requirements for an M.S. in Computer Engineering and an M.S. in Electrical Engineering. The program is normally completed in four semesters of full-time study.

Admission requirements for the CPE/EE are the same as those for admission to the Master of Science in Computer Engineering or electrical engineering. Students whose accredited B.S. degree is not in computer and/or electrical engineering may pursue the CPE/EE degree, provided that they have an adequate background and can demonstrate proficiency in the material contained in the following undergraduate courses: ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 242 or CS 350 (Digital Computers and Computing), ECE 311 (Engineering Electronics), CS 201 (i.e., CS 115 and CS 116 combined, Object Oriented Programming III), CS 401 (Introduction to Advanced Studies in CS), and MATH 252 (Introduction to Differential Equations). A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department.

The description of the CPE areas of concentration is in the Master of Science in Computer Engineering section. A description of the EE areas of concentration is in the Master of Science in Electrical Engineering section.

In addition to all university requirements for a Master of Science degree, the M.S.CP.E./E.E. degree has the following requirements:

1. A minimum of 45 credit hours of graduate level coursework including:

Two core courses in a CPE major area, chosen from among the CPE areas of concentration.

Two elective courses in the CPE major area, chosen from among the CPE areas of concentration.

One core course from each of two remaining areas of CPE concentration.

Four (or more) courses within an EE major area, chosen from among the EE areas of concentration (Areas I, II and III).

One (or more) course(s) in each of two EE minor areas, chosen from among the Areas I, II and III outside the major.

One advanced mathematics course required for EE major area unless included in the B.S. degree.

Additional coursework approved by the academic advisor

The CPE/EE Program is subject to the following restrictions: a minimum of 30 credit hours of coursework at the 500-level or higher; at least 30 credit hours of ECE courses excluding short courses and Master's Seminars; no more than six credit hours of ECE short courses; six to eight credit hours of research work (ECE 591) leading to an M.S. dissertation may be included with the approval of a thesis advisor; and a maximum of two credits of a Master's Seminar (ECE 595 and ECE 596)

2. A GPA of at least 3.0/4.0 (excluding prerequisites and proficiencies).

Courses classified in two areas may be applied to only one area to fulfill requirements. Intersession short courses may not be used to satisfy distribution requirements in major and minor areas.

Each regular (matriculated) graduate student is assigned an academic advisor, indicated in his/her formal letter of admission to the master's program.

Students should consult with their academic advisor to file a program of study meeting these requirements prior to four months after initial registration for full-time students and prior to enrolling beyond 12 credits for part-time students.

Master of Electrical and Computer Engineering

30 credit hours

The purpose of this degree is to prepare students for leading edge positions in industry in the field of electrical and computer engineering. The Master of Electrical and Computer Engineering (M.E.C.E.) is a course-only degree program that prepares students for professional practice in electrical and computer engineering. The program can be completed in one year of full-time study. Students whose accredited B.S. degree is not in electrical engineering or computer engineering may pursue the M.E.C.E. provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to IITs ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 307 (Electrodynamics), ECE 308 (Signals and Systems), ECE 311 (Engineering Electronics), MATH 251 (Multivariate and Vector Calculus), and MATH 252 (Introduction to Differential Equations). Students should visit the appropriate department for

course descriptions. A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department.

The program of study includes a minimum of 30 credit hours of acceptable graduate coursework, with a minimum of 24 credit hours in electrical and computer engineering and a minimum of 18 credit hours at the 500-level or higher. Up to six credits of ECE short courses may be applied to the degree. Students arrange their program of study in consultation with their advisor and typically elect to build their program to emphasize one or more areas of specialization. No formal distribution requirements are imposed. Areas of specialization include communication systems, computer communication, computer engineering, control systems, electromagnetics, electronics, networks, photonics and optics, power systems and signal processing

Master of Biomedical Imaging and Signals

30 credit hours

The purpose of this degree program is to prepare students for leading edge positions in industry in the areas of biomedical imaging and signal processing. The Professional Master of Biomedical Imaging and Signals is a course-only degree program that prepares students for professional practice.

The interdisciplinary nature of bioengineering generally involves many facets of electrical and computer engineering. The Department of Electrical and Computer Engineering offers several courses and research opportunities that engage students interested in biomedical engineering. In addition, there are a significant number of courses offered by the Biomedical Engineering Department and other disciplines at IIT which are of great importance to students interested in the professional master's degree in biomedical engineering with specialization in medical imaging and bio-signals.

The admission requirements for the proposed degree will follow the existing admission requirements for such professional master's degrees in ECE Department. Students whose accredited B.S. degree is not in electrical and computer engineering may pursue the professional master's degree provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to IIT's ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 307 (Electrodynamics), ECE 308 (Signals and Systems), ECE 311 (Engineering Electronics), BIOL 107 (General Biology Lectures), MATH 251 (Multivariate and Vector Calculus), and MATH 252 (Introduction to Differential Equations). A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department. Students can pursue a professional master's degree in the area of Biomedical Imaging and Signals by completing the required core and elective courses.

Required courses

ECE 511 Analysis of Random Signals
ECE 565 Computer Vision and Image Processing

AND/OR

ECE 481 Image Processing
ECE 569 Digital Signal Processing II

AND/OR

ECE 437 Digital Signal Processing I
BME 450 Physiology

OR

BIOL 430 Animal Physiology

ECE Elective courses

(2 courses minimum)

ECE 505 Applied Optimization for Engineers
ECE 566 Statistical Pattern Recognition
ECE 567 Statistical Signal Processing
ECE 568 Digital Speech Processing
ECE 597 Special Project in Biomedical Imaging and Signals

BME Elective courses

(1 course minimum)

BME 430 Concepts of Medical Engineering
BME 501 Biomedical Instrumentation
BME 532 Medical Imaging Science
BME 535 Magnetic Resonance Imaging
BME 538 Neuroimaging
BME 540 Wave Physics and Applied Optics for Imaging Scientists
BME 551 Physiological Signal Analysis & Control Theory I
BME 552 Physiological Signal Analysis & Control Theory II

Master of Power Engineering

30 credit hours

The purpose of this degree program is to prepare students for leading edge positions in industry in the areas of electric power, power electronics, motor drives, and electric machines. The Professional Master of Power Engineering is a course-only degree program that prepares students for professional practice in power engineering.

The admission requirements for the proposed degree will follow the existing admission requirements for such professional master's degrees in ECE Department. Students whose accredited B.S. degree is not in electrical engineering may pursue the professional masters degree provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to IITs ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 311 (Engineering Electronics), ECE 319 (Fundamentals of Power Engineering), MATH 251 (Multivariate and Vector Calculus), and MATH 252 (Introduction to Differential Equations). A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the ECE department.

The program of study includes a minimum of 30 credit hours of acceptable coursework with a minimum of 24 credit hours from the following list of core and elective courses (up to 6 credit hours may be selected from other ECE courses). A minimum of 18 credit hours at the 500-level or higher must be selected. Up to 2 credit hours of the Masters Seminar (ECE 595 or ECE 596), up to 3 credit hours of a Graduate Special Project in power engineering (ECE 594 or ECE 597), and up to 6 credit hours of ECE short courses may be applied to the degree.

Required courses

(3 courses minimum)

ECE 412 Electric Motor Drives
ECE 418 Power Systems Analysis

OR

ECE 419 Power Systems Analysis
ECE 551 Advanced Power Electronics

AND/OR

ECE 411 Power Electronics
ECE 564 Control and Operation of Electric Power Systems

AND/OR

ECE 420 Analytical Methods in Power Systems

Elective courses in Power Systems

(2 courses minimum)

ECE 417 Power Distribution Engineering
ECE 420 Analytical Methods in Power Systems
ECE 553 Power System Planning
ECE 554 Power Systems Relaying
ECE 555 Power Market Operations
ECE 556 Power Market Economics and Security
ECE 557 Fault-Tolerant Power Systems
ECE 558 Power System Reliability
ECE 559 High-Voltage Power Transmission
ECE 560 Power Systems Dynamics and Stability
ECE 561 Deregulated Power Systems
ECE 562 Power System Transaction Management
ECE 563 Computational Intelligence in Engineering
CHE 543 Energy, Environment and Economics

Elective courses in Power Electronics and Motor Drives

(2 courses minimum)

ECE 437 Digital Signal Processing I
ECE 438 Control Systems
ECE 531 Linear System Theory
ECE 549 Motion Control Systems Dynamics
ECE 550 Power Electronic Dynamics and Control
ECE 552 Adjustable Speed Drives
ECE 762 Industrial Applications of Power Electronics and Motor Drives
ECE 764 Vehicular Power Systems
CHE 541 Renewable Energy Technologies
CHE 524 Design Building Enclosures

Master of VLSI and Microelectronics

30 credit hours

The purpose of this degree program is to prepare students for leading edge positions in industry in the areas of VLSI and microelectronics. The Professional Master of VLSI and Microelectronics is a course-only degree program that prepares students for professional practice. Students can pursue a professional master's degree in the area of VLSI and Microelectronics by completing the required core courses; ECE 425, ECE 429, ECE 529, and ECE 575 (and/or ECE 415) and selecting six additional courses from a combination of computer engineering electives, electronics electives, and other areas in electrical and computer engineering. A minimum of 18 credit hours at the 500-level or higher must be selected. With advisor approval the student may take up to two ECE courses in other areas of electrical and computer engineering such as signal processing, communications, power and control.

The admission requirements for the proposed degree will follow the existing admission requirements for such professional masters degrees in ECE Department. Students whose accredited B.S. degree is not in electrical engineering may pursue the professional master's degree provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to IITs ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 307 (Electrodynamics), ECE 308 (Signals and Systems), ECE 311 (Engineering Electronics), MATH 251 (Multivariate and Vector Calculus), and MATH 252 (Introduction to Differential Equations). A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the ECE department.

Required courses

(2 courses minimum)

- ECE 425 Analysis and Design of Integrated Circuits
- ECE 429 Introduction to VLSI Design
- ECE 529 Advanced VLSI Systems Design
- ECE 575 Advanced Power Electronics

AND/OR

- ECE 415 Solid-State Electronics

Elective courses in Computer Engineering

(1 course minimum)

- ECE 485 Computer Organization and Design
- ECE 530 High Performance VLSI/IC Systems
- ECE 542 Design and Optimization of Computer Networks
- ECE 545 Advanced Computer Networks
- ECE 583 High Speed Computer Arithmetic
- ECE 584 VLSI Architectures for Signal Processing and Communications
- ECE 585 Advanced Computer Architecture
- ECE 586 Fault Detection in Digital Circuits
- ECE 587 Hardware/Software Co-design
- ECE 588 CAD Techniques for VLSI Design
- ECE 589 Computer Aided-Design of Analog IC

Elective courses in Electronics

(1 course minimum)

- ECE 521 Quantum Electronics
- ECE 524 Advanced Electronic Circuit Design
- ECE 525 RF Integrated Circuit Design
- ECE 526 Active Filter Design
- ECE 527 Performance Analysis of RF Integrated Circuits
- ECE 551 Advanced Power Electronics
- ECE 570 Fiber Optic Communication Systems
- ECE 571 Nanodevices and Technology
- ECE 578 Microwave Theory
- ECE 579 Numerical Methods in Electromagnetics and Solid-State Electronics

Master of Network Engineering

30 credit hours

The Master of Network Engineering (M.N.E.) is a course only degree program that prepares students for professional practice in network engineering and information technologies. The program offered by the Department of Electrical and Computer Engineering (ECE) can be completed in one year of full-time study. A person holding a B.S.E.E. or a B.S.CP.E degree has the necessary background to undertake the M.N.E. program. A student without adequate background is required to demonstrate proficiency in the following courses: ECE 211 (Circuit Analysis I), ECE 213 (Circuit Analysis II), ECE 308 (Signals and Systems), MATH 252 (Introduction to Differential Equations), MATH 474 (Probability), and CS 401 (Introduction to Advanced Studies in Computer Science). A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department.

The M.N.E. is a focused professional master's degree requiring a minimum of 30 credit hours of advisor-approved coursework. The M.N.E. program of studies must include a minimum of 24 credit hours of ECE coursework, 12 credit hours of required core courses, 12 credit hours of MNE elective courses, and six credit hours of advisor approved elective courses. At least 18 credit hours of the courses must be at the 500 level. A maximum of six credit hours may be taken from the ECE 700-level short courses.

Required courses (12 credit hours)

ECE 407 Introduction to Computer Networks with Laboratory

OR

ECE 408 Introduction to Computer Networks

AND/OR

ECE 545 Advanced Computer Networks

AND

ECE 511 Analysis of Random Signals

ECE 513 Communication Engineering Fundamentals

ECE 541 Performance Evaluation of Computer Networks

AND/OR

ECE 542 Design and Optimization of Computer Networks

Elective courses

(12 credit hours)

This coursework is taken from the 400-, and 500-level courses listed below, and approved by the M.N.E. advisor. A maximum of six credit hours of ECE short courses can be included in the M.N.E. program of studies.

ECE 403 Communication Systems

ECE 404 Digital and Data Communications

ECE 437 Digital Signal Processing I

OR

ECE 436 Digital Signal Processing I with Laboratory

ECE 485 Computer Organization and Design

ECE 504 Wireless Communication System Design

ECE 508 Video Communications

ECE 514 Digital Communication Principles

ECE 515 Modern Digital Communications

ECE 519 Coding for Reliable Communications

ECE 543 Computer Network Security

ECE 544 Wireless and Mobile Networks

ECE 546 Wireless Network Security

ECE 565 Computer Vision and Image Processing

ECE 568 Digital Speech Processing

ECE 569 Digital Signal Processing II

ECE 570 Fiber-Optic Communication Systems

ECE 583 High Speed Computer Arithmetic

ECE 584 VLSI Architectures for Signal Processing and Communications

ECE 585 Digital Computer Design

CS 455 Data Communications

CS 548 Broadband Networks

Master of Telecommunications and Software Engineering

30 credit hours

The Master of Telecommunications and Software Engineering (M.T.S.E.) is a course-only degree program that prepares students for professional practice in telecommunications and information technologies. The program, jointly offered by the Department of Electrical and Computer Engineering (ECE) and Department of Computer Science (CS), can be completed in one year of full-time study.

Eligibility: A person holding a B.S.E.E., a B.S.C.P.E. or a B.S.C.S. degree has the necessary broad background to undertake the M.T.S.E. program. A student without adequate background in specific areas is required to demonstrate proficiency in prerequisite courses; an abbreviated list is given below.

Specific proficiency courses will be detailed for each student at the time of admission to the M.T.S.E. program. A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department.

M.T.S.E. Curriculum

Required courses

- ECE 407 Introduction to Computer Networks with Laboratory **OR**
- ECE 408 Introduction to Computer Networks **AND/OR**
- ECE 545 Advanced Computer Networks
- ECE 513 Communication Engineering Fundamentals
- ECE 541 Performance Evaluation of Computer Networks **AND/OR**
- ECE 542 Design and Optimization of Computer Networks
- CS 586 Software Systems Architecture
- CS 587 Programming Project Management

Elective categories

I. Software Engineering

- CS 521 Object-Oriented Analysis and Design
- CS 537 Software Metrics
- CS 589 Software Testing and Analysis

II. Telecommunication Systems

- ECE 543 Computer Network Security
- ECE 544 Wireless and Mobile Networks
- ECE 546 Wireless Network Security
- CS 544 Computer Networks II: Network Services
- CS 548 Broadband Networks
- CS 555 Analytic Models and Simulation of Computer Systems

III. Telecommunications

- ECE 504 Wireless Communication System Design

Computer science prerequisites

- CS 201 (i.e., CS 115 and CS 116 combined, Object-Oriented Programming I-II)
- CS 401 Introduction to Advanced Studies

Electrical and Computer Engineering prerequisites

- ECE 211 Circuit Analysis I
- ECE 213 Circuit Analysis II
- ECE 308 Signals and Systems
- MATH 252 Introduction to Differential Equations
- MATH 474 Probability

The M.T.S.E. is a professional master's degree requiring a minimum of 30 credit hours of advisor-approved coursework. The M.T.S.E. program of studies must include a minimum of 15 credit hours of ECE coursework and a minimum of 12 credit hours of computer science coursework.

Five required courses and one elective course from each of the three categories given below must appear on the M.T.S.E. program of studies.

-
- ECE 514 Digital Communication Principles
 - ECE 515 Modern Digital Communications
 - ECE 519 Coding for Reliable Communications

The remaining nine credit hours of coursework may be taken from courses listed above, or other courses approved by the M.T.S.E. advisor. Students without a background in communications or software engineering should consider including in their program of studies:

- ECE 403 Communication Systems
- CS 487 Software Engineering I
- CS 450 Operating Systems I
- CS 455 Data Communications

Other courses that students in this program typically choose from include:

- ECE 437 Digital Signal Processing I
- ECE 508 Signal and Data Compression
- ECE 511 Analysis of Random Signals
- ECE 515 Modern Digital Communications
- ECE 565 Computer Vision and Image Processing
- ECE 568 Digital Speech Processing
- ECE 569 Digital Signal Processing II
- ECE 584 VLSI Architectures for Signal Processing and Communications
- CS 588 Advanced Software Engineering Development

With advisor approval, the M.T.S.E. program of studies can include up to two credit hours of Masters Seminar (ECE 595, ECE 596). It can also include up to four credit hours of ECE short courses.

Master of Electricity Markets

30 credit hours

Deregulation is bringing major changes to the electric power industry. Electricity is now traded in commodity markets, and these new markets affect the way the electric power grid is controlled and operated. Electrical engineers need to understand both the technical and the business sides of these changes in order to address the needs of the electric power industry.

IIT's Department of Electrical and Computer Engineering and Center for Financial Markets have teamed up

to develop new masters degree and graduate certificate programs in electricity markets. Combining existing and new courses from the graduate programs in electrical engineering and in financial markets and trading, the programs provide graduate-level education in electricity markets suitable for electric power engineers. The program of study includes a minimum of 30 credit hours of acceptable graduate coursework, with a minimum of 18 credit hours at the 500 level or higher. Up to two credits of Master's Seminar (ECE 595 or ECE 596) and up to six credits of accelerated courses may be applied to the degree. A background in finance is not required.

Curriculum

Core courses

ECE 555 Power Market Operations
ECE 561 Deregulated Power Systems
ECE 562 Power System Transaction Management
ECE 564 Control and Operation of Electric Power Systems
FM 553 Valuing Energy Derivatives
FM 552 Introduction to Energy Markets

Select two additional courses from the following:

ECE 417 Power Distribution Engineering
ECE 419 Power System Analysis with Laboratory

OR

ECE 418 Power Systems Analysis
ECE 420 Advanced Power System Analysis
ECE 550 Power Electronic Dynamics and Control
ECE 553 Power Systems Planning
ECE 554 Power Systems Relaying
ECE 556 Power Market Economics and Security
ECE 557 Fault-Tolerant Power Systems
ECE 558 Power System Reliability
ECE 559 High Voltage Power System Relaying
ECE 560 Power Systems Dynamics and Stability
ECE 563 Computational Intelligence in Engineering
ECE 531 Linear System Theory
ECE 580 Elements of Sustainable Energy
ECE 581 Elements of Smart Grid

Six additional credit hours of electives are chosen from the offerings of the Department of Electrical and Computer Engineering, including the list of power courses above.

Doctor of Philosophy in Electrical Engineering

84 credit hours, including master's degree studies
Qualifying exam
Comprehensive exam (dissertation proposal defense)
Dissertation
Oral dissertation defense

The doctorate degree in electrical engineering is awarded in recognition of mastery in the field of electrical engineering and upon demonstration of an ability to make substantial creative contributions to knowledge in that field. The Ph.D. recipient will be capable of a continuing effort toward the advancement of knowledge and achievement in research and other scholarly activities. This program is appropriate for those students with master's degrees who are interested in pursuing an academic or industrial research career.

The Ph.D. program requires a minimum of 84 credit hours beyond the bachelor's degree, including the master's degree studies. A minimum of 24 credits are devoted to the student's research work, and a minimum of 24 credits are devoted to coursework in electrical and computer engineering and in such basic sciences as mathematics and physics. The selection of courses is considered and approved by the student's advisor and the department's graduate program director on the basis of relevance of course content, rather than along a predetermined sequence announced by the department.

Work toward the Ph.D. generally takes a minimum of three years of study beyond the master's degree. Upon admission to graduate study leading to the Ph.D. degree, each student is assigned an academic advisor, who may eventually serve as the thesis advisor and guides the student's research.

The department requires a qualifying examination within the first three semesters of full-time Ph.D. studies. This is a written examination consisting of several areas in electrical and computer engineering. This examination is intended to explore both the depth and breadth of the student's academic abilities. At an early stage in the student's research program, and usually about a year after passing the qualifying examination, a comprehensive examination is held in the area of specialization.

The comprehensive examination takes the form of an oral presentation and defense of a thesis research proposal. At this time a thesis committee is appointed by the graduate program director, in consultation with the thesis advisor, to guide the remainder of the program. A written dissertation, oral defense and publication requirement constitute completion of the Ph.D. degree. The defense takes place no earlier than one year after passing the comprehensive examination. Dissertation format and deadlines are established by the Graduate College.

Doctor of Philosophy in Computer Engineering

84 credit hours, including master's degree studies
Qualifying exam
Comprehensive exam (dissertation proposal defense)
Dissertation
Oral dissertation defense

The doctorate degree in computer engineering is awarded in recognition of mastery in the field of computer engineering and upon demonstrating the ability to make fundamental contributions to knowledge in that field. The Ph.D. recipient will be capable of making a continuing effort toward the advancement of knowledge and achievement in research and other scholarly activities. This program is appropriate for those students with a master's degree in computer and/or electrical engineering who are interested in pursuing an academic or industrial research career.

The Ph.D. program requires a minimum of 84 credit hours beyond the bachelor's degree, including the master's degree studies. A minimum of 24 credits are devoted to the student's research work, and a minimum of 24 credits are devoted to course work in computer and electrical engineering and in basic sciences, such as computers, mathematics, and physics. The selection of courses is considered and approved by the student's advisor and the department's graduate program director on the basis of relevance of course content, rather than

along a predetermined sequence announced by the department. Generally, it takes a minimum of three years of study beyond the master's degree to obtain a Ph.D.

Upon admission to graduate study leading to the Ph.D. degree, each student is assigned an academic advisor, who may eventually serve as the thesis advisor and guide the student's research. The department requires a qualifying examination within the first three semesters of full-time Ph.D. study. This is a written examination consisting of covering topics in the area of digital and computer systems and at least one minor area in the field of electrical engineering. This examination is intended to explore both the depth and breadth of the student's academic abilities. At an early stage in the student's research program, and usually about a year after passing the qualifying examination, a comprehensive examination is held in the area of digital and computer systems. The comprehensive examination takes the form of a defense of a thesis research proposal. At this time a thesis committee is appointed by the graduate program director, in consultation with the thesis advisor, to guide the remainder of the program. A written dissertation, oral defense, and publication requirement constitute completion of the Ph.D. degree. The defense takes place no earlier than one year after passing the comprehensive examination. Dissertation format and deadlines are established by the Graduate College.

Certificate Programs

Certificate programs provide a student with post baccalaureate knowledge in an area of specialization within electrical and computer engineering. Students in these programs register as certificate non-degree seeking students. Certificates are granted upon completion of all course requirements in the chosen specialization area, as listed below with a minimum GPA of 3.0. Certificate programs must be completed within five years.

It is the student's responsibility to meet all course prerequisites. Any student admitted to a masters degree program offered by the department may apply coursework completed in the certificate program toward the masters degree requirements

Advanced Electronics

This program is composed entirely of elective courses and provides advanced study in electronic design and device theory for those who wish to enhance their analog and digital design skills, while increasing their knowledge of the underlying device physics. A maximum of two 400 level courses may be taken.

Elective courses

(Four from the following)

- ECE 411 Power Electronics
- ECE 412 Electric Motor Drives

- ECE 425 Analysis and Design of Integrated Circuits
- ECE 521 Quantum Electronics
- ECE 524 Electronic Circuit Design
- ECE 525 RF Integrated Circuit Design
- ECE 526 Active Filter Design
- ECE 527 Performance Analysis of RF Integrated Circuits
- ECE 529 Advanced VLSI Design
- ECE 530 High Performance VLSI/IC Systems
- ECE 571 Nanodevices and Technology
- ECE 575 Electron Devices

Applied Electromagnetics

In this certificate program, students receive advanced preparation for careers in electromagnetic engineering, particularly in areas of RF circuits and systems, electromagnetic wave propagation, antenna theory, and electromagnetic compatibility.

Required courses

- ECE 421 Microwaves Circuits and Systems
- OR**
- ECE 423 Microwave Circuits and Systems with Laboratory
- ECE 509 Electromagnetic Theory

Elective courses

(Two from the following)

- ECE 522 Electromagnetic Compatibility
- ECE 571 Nanodevices and Technology
- ECE 576 Antenna Theory
- ECE 578 Microwave Theory

Communication Systems

For those who want to become proficient in communication system principles and applications, this certificate program contains two fundamental courses and a large number of elective courses for emphasis in data compression, computer networks, and analog/digital communications. No more than one course may be a 400-level course.

Required courses

- ECE 511 Analysis of Random Signals
- ECE 513 Communication Engineering Fundamentals

Elective courses

(Two from the following)

- ECE 403 Digital and Data Communication Systems **OR**
- ECE 405 Digital and Data Communication Systems with Laboratory
- ECE 514 Digital Communication Principles
- ECE 515 Modern Digital Communications
- ECE 519 Coding for Reliable Communications
- ECE 541 Performance Evaluation of Computer Networks
- ECE 542 Design and Optimization of Computer Networks
- ECE 543 Computer Network Security
- ECE 544 Wireless and Mobile Networks
- ECE 545 Advanced Computer Networks
- ECE 546 Wireless Network Security

Computer Engineering

Graduates of this program gain proficiency in one of several areas, including VLSI design, computer networks, computer hardware and software design. A maximum of one 400-level course may be taken, including ECE 429 if selected as a required course.

Required courses

ECE 429 Introduction to VLSI Design **AND/OR**

ECE 529 Advanced VLSI Systems Design

AND

ECE 585 Advanced Computer Architecture

Elective courses

(Two from the following)

ECE 441 Microcomputers

ECE 446 Advanced Logic Design

ECE 448 Computer Systems Programming

ECE 449 Object-Oriented Programming and Computer Simulation

ECE 485 Computer Organization and Design

ECE 530 High Performance VLSI/IC Systems

ECE 541 Performance Evaluation of Computer Networks

ECE 542 Design and Optimization of Computer Networks

ECE 543 Computer Network Security

ECE 544 Wireless and Mobile Networks

ECE 546 Wireless Network Security

ECE 545 Advanced Computer Networks

ECE 583 High Speed Computer Arithmetic

ECE 584 VLSI Architectures for Signal Processing and Communications

ECE 586 Fault Detection in Digital Circuits

ECE 587 Hardware/Software Codesign

ECE 588 CAD Techniques for VLSI Design

ECE 589 Computer-Aided Design of Analog IC

Control Systems

Engineers who deal with the control and optimization of systems will benefit from the focused coursework in this program, providing intensive studies in linear and non-linear systems, optimized control, controllability and stability of systems, and analysis and synthesis of control systems.

Required courses

ECE 531 Linear System Theory

ECE 535 Discrete Time Control Systems

Elective courses

(Two from the following)

ECE 438 Control Systems **OR**

ECE 506 Analysis of Nonlinear Systems

ECE 550 Power Electronic Dynamics and Control

Electricity Markets

This program is an introduction to both the technical and business sides of a deregulated electric power industry.

Required courses

ECE 561 Deregulated Power Systems

FMT 540 Valuing and Managing Energy Derivatives

FMT 542 Introduction to Energy Markets

Two ECE accelerated courses

Power Electronics

In this certificate program, students receive professional preparation in the areas of power electronic converters, industrial electronics, switching power supplies, electric/electronic motor drives, and electric power quality. This certificate program would be useful to managers, engineers, and students who are seeking a position in power electronics related industry.

Required courses

(Choose at least two)

- ECE 550 Power Electronic Dynamics and Control
- ECE 551 Advanced Power Electronics
- ECE 552 Adjustable Speed Drives
- ECE 411 Power Electronics **OR**
- ECE 412 Electric Motor Drives

Elective areas

I. Power area

- ECE 548 Energy Harvesting
- ECE 561 Deregulated Power Systems
- ECE 563 Computational Intelligence in Engineering
- ECE 564 Control and Operation of Electric Power Systems

II. Electronics area

- ECE 437 Digital Signal Processing I
- ECE 539 Computer Aided Design of Electric Machines
- ECE 575 Electron Devices

III. Control area

- ECE 438 Control Systems
- ECE 531 Linear System Theory
- ECE 535 Discrete Time Systems

IV. Special topics area

Accelerated course(s) in power electronics

Power Engineering

This program provides power engineers with a solid foundation in the design and analysis of large-scale power systems and state-of-the-art power conversion systems, including power systems control, power electronics, motor drives, design of fault-tolerant systems, power markets, and fundamentals of power system operation and planning.

Required course

(Choose one)

- ECE 411 Power Electronics
- ECE 412 Electric Motor Drives
- ECE 419 Power Systems Analysis with Laboratory **OR**
- ECE 418 Power Systems Analysis
- ECE 420 Analytical Methods in Power Systems

Elective courses

(Choose three)

- ECE 417 Power Distribution Engineering
- ECE 538 Renewable Energies
- ECE 539 Computer Aided Design of Electric Machines
- ECE 540 Reliability Theory and System Implementation
- ECE 548 Energy Harvesting
- ECE 549 Motion Control Systems Dynamics
- ECE 550 Power Electronic Dynamics and Control
- ECE 551 Advanced Power Electronics
- ECE 552 Adjustable Speed Drives
- ECE 553 Power System Planning
- ECE 554 Power Systems Relaying
- ECE 555 Power Market Operations
- ECE 556 Power Market Economics and Security
- ECE 557 Fault-Tolerant Power Systems
- ECE 558 Power System Reliability
- ECE 559 High-Voltage Power Transmission
- ECE 560 Power Systems Dynamics and Stability
- ECE 561 Deregulated Power Systems
- ECE 562 Power System Transaction Management
- ECE 563 Computational Intelligence in Engineering
- ECE 564 Control and Operation of Electric Power Systems

Signal Processing

Those seeking expertise in the areas of signal and image processing should take this program, which offers a wide range of advanced courses in the areas of digital signal processing, data compression, image and speech processing, and pattern recognition.

Required courses

ECE 511 Analysis of Random Signals
ECE 569 Digital Signal Processing II

Elective courses

(Choose two; no more than one may be a 400-level course.)

ECE 436 Digital Signal Processing I with Laboratory
ECE 437 Digital Signal Processing I
ECE 481 Image Processing
ECE 507 Imaging Theory and Applications
ECE 508 Video Communications
ECE 565 Computer Vision and Image Processing
ECE 566 Statistical Pattern Recognition
ECE 567 Statistical Signal Processing
ECE 568 Digital Speech Processing
ECE 584 VLSI Architectures for Signal Processing and Communications

Wireless Communication Engineering

For communications engineers who want a focused program providing state-of-the-art instruction in the growing field of wireless communications, this program offers fundamental coursework in traditional telecommunications system design as well as computer communication networks.

Required courses

ECE 504 Wireless Communication System Design
ECE 513 Communication Engineering Fundamentals

Elective courses

(Choose two; no more than one may be a 400-level course.)

ECE 403 Digital and Data Communication Systems
ECE 515 Modern Digital Communications
ECE 519 Coding For Reliable Communications
ECE 541 Performance Evaluation of Computer Networks
ECE 544 Wireless and Mobile Networks
ECE 545 Advanced Computer Networks
ECE 546 Wireless Network Security
ECE 576 Antenna Theory

Course Descriptions

Numbers in parentheses indicate class, lab and credit hours, respectively.

ECE 502

Basic Network Theory

Steady-state analysis of linear networks. Introduction to topology and the derivation of mesh, nodal and terminal pair relations using topological concepts with applications to computer-aided analysis of networks. Network interconnections. Indefinite admittance matrix. Prerequisite: B.S.E.E. degree.
(3-0-3)

ECE 504

Wireless Communication Network Design

Fundamentals of wireless communications, with emphasis on the underlying theory, design techniques, and analytical tools. Overview of wireless systems. Characteristics of wireless channels and their capacity limits. Audio, image and video coding standards. Modulation and coding for wireless channels. Diversity and Equalization techniques. Multiuser communications. Spread spectrum techniques. Multicarrier modulation. Wireless systems: Cellular systems: AMPS, TDMA, CDMA, and WCDMA - design, standards, performance studies. Wireless LAN systems (WiFi, WiMAX): design and standards. Prerequisite: ECE 513.
(3-0-3)

ECE 505

Applied Optimization for Engineers

Principles of optimization for practical engineering problems, linear programming, nonlinear unconstrained optimization, nonlinear constrained optimization, dynamic programming. Prerequisite: B.S. degree in engineering, math or science, or permission of instructor.
(3-0-3)

ECE 506

Analysis of Nonlinear Systems

Graphical and analytical methods, phase plane and singular points, periodic oscillations and limit cycles, forced nonlinear systems, jumps, subharmonics and frequency entrainment; stability analysis using Liapunov, Popov and circle criteria; introduction to describing functions.
(3-0-3)

ECE 507

Imaging Theory and Applications

Image formation methods including optical (photography), tomography, image formation with arrays of sensors, interferometry, and surface imaging. Technologies of image acquisition including digital cameras, radar/sonar, and medical imaging techniques such as magnetic resonance imaging, computed tomography, positron emission tomography, optical imaging, electroencephalography, and magnetoencephalography. Throughout the semester, the course will also focus on the reconstruction of images based on the raw data obtained from various imaging techniques.
(3-0-3)

ECE 508

Video Communications

This graduate-level course covers the fundamentals of video coding and communications. The principles of source coding for the efficient storage and transmission of video will be covered. State-of-the-art video coding standards and error-resilient video coding techniques will be introduced. Recent technologies for robust transmission of video data over wired/wireless networks will be discussed. A detailed overview of architectural requirements for supporting video communications will be presented. Error control and cross-layer optimization techniques for wireless communications will be covered.
(3-0-3)

ECE 509

Electromagnetic Field Theory

Electric and magnetic fields produced by charge and current distributions. Solution of Laplace's and Poisson's equations, time-varying fields and electromagnetic waves. Applications to waveguides and antennas. Prerequisite: ECE 307.
(3-0-3)

ECE 511

Analysis of Random Signals

Probability theory, including discrete and continuous random variables, functions and transformations of random variables. Random processes, including correlation and spectral analysis, the Gaussian process and the response of linear systems to random processes. Prerequisites: ECE 308 and MATH 474.
(3-0-3)

ECE 513

Communication Engineering Fundamentals

Review of probability and random processes. AM with noise, FM with noise. Introduction to digital communication. Source coding, signal space analysis, channel modulations, optimum receiver design, channel encoding. Prerequisites: ECE 403 and MATH 474.
(3-0-3)

ECE 514

Digital Communication Principles

Information transmission fundamentals, including capacity, entropy, Shannon's theorems and source coding. Introduction to rate distortion theory. Advanced digital modulation and demodulation techniques, performance measures. Carrier and symbol synchronization. Signal design for band-limited channels. Prerequisites: ECE 511, ECE 513.
(3-0-3)

ECE 515

Modern Digital Communication

Review of modulation and coding. Trellis coded modulation. Digital signaling over fading multipath channels. Spread spectrum signals for digital communications. Multichannel and multicarrier signals for digital communications. Multiuser communications, time-division multiple access, code-division multiple access, frequency-division multiple access. Advanced communications systems. Prerequisite: ECE 511, ECE 513.
(3-0-3)

ECE 519

Coding for Reliable Communications

Encoders and decoders for reliable transmission of digital data over noisy channels. Linear block codes, cyclic codes, BCH codes, convolutional codes. Burst error correcting codes. Maximum likelihood decoding of convolutional codes. Performance of block and convolutional codes in additive white Gaussian channel. Turbo codes and low density parity check codes. Prerequisite: MATH 474.

(3-0-3)

ECE 521

Quantum Electronics

The Schrodinger equation. Matrix formulation. Quantization of lattice vibrations and electromagnetic fields. Optical beams and resonators. The interaction of radiation and atomic systems. Lasers. Optical waveguides and devices. Frequency conversion. Quantum noise. Same as PHYS 521. Prerequisite: ECE 307.

(3-0-3)

ECE 522

Electromagnetic Compatibility

Development of design procedures for minimizing interference between electronic circuits and systems. sources of conducted and radiated interference. Interference coupling mechanisms. Shielding theory. Grounding, bonding and filtering methods. special equipment design procedures. Problems associated with digital equipment. Measurement methods. Prerequisite: ECE 307 or equivalent.

(3-0-3)

ECE 524

Advanced Electronic Circuit Design

RF amplifiers and oscillators. Low and high power RF amplifier design techniques. Stability of amplifiers. LC and crystal oscillators. FM demodulators and limiters. Mixer design. Circuit design to minimize intermodulation and other forms of distortion. Prerequisites: ECE 307, ECE 312.

(3-0-3)

ECE 525

RF Integrated Circuit Design

Essentials of contemporary RF CMOS integrated circuit analysis and design. Typical RF building blocks in CMOS and BiCMOS technologies, including passive IC components, MOS transistors, RLC tanks, distributed networks, RF amplifiers, voltage reference and biasing circuits, LNA, mixers, power amplifiers, and feedback networks. RF device modeling, Smith chart, bandwidth estimation and stability analysis techniques. RF IFC team design projects. Prerequisites: ECE 312 and senior or graduate standing.

(3-0-3)

ECE 526

Active Filter Design

Analysis and design of linear active filters with emphasis on realizations using operational amplifiers. Sensitivity analysis. Switched capacitor filters. Prerequisites: ECE 308, ECE 312.

(3-0-3)

ECE 527

Performance Analysis of RF Integrated Circuits

Essentials of analysis techniques for nonlinear effects and noises in contemporary RF integrated circuit design. Nonlinear and distortion behaviors including intermodulation, cross-modulation, harmonics, gain compression, desensitization, spurious, etc. Noise effects including thermal, short, Flicker, burst noises, etc. RF IC devices and circuits including resistors, capacitors, inductors, diodes, BJTs, FETs, low-noise amplifiers, mixers, power amplifiers, etc. Analysis skills for single-stage and multiple-stage networks. RF IC team design projects. Prerequisites: ECE 312, Senior or Graduate student standing.

(3-0-3)

ECE 529

Advanced VLSI Systems Design

Advanced design and application in VLSI Systems. The topics of this course include design tools and techniques, clocking issues, complexity management, layout and floorplanning, array structures, testing and testability, advanced arithmetic circuitry, transcendental function approximations, architectural issues, signal processing architectures, submicron design. Design project are completed and fabricated by student teams. Prerequisites: Graduate standing and ECE 429.

(3-0-3)

ECE 530

High Performance VLSI/IC Systems

Background and insight into some of the most active performance-related research areas of the field is provided. Issues covered include CMOS delay and modeling, timing and signal delay analysis, low power CMOS design and analysis, optimal transistor sizing and buffer tapering, pipelining and register allocation, synchronization and clock distribution, retiming, interconnect delay, dynamic CMOS design techniques, asynchronous vs. synchronous tradeoffs, BiCMOS, low power design, and CMOS power dissipation. Historical, primary, and recent papers in the field of high-performance VLSI digital and analog design and analysis are reviewed and discussed. Each student is expected to participate in the class discussions and also lead the discussion surveying a particular topic. Prerequisites: Graduate standing and ECE 429.

(3-0-3)

ECE 531

Linear System Theory

Linear spaces and operators, single and multivariable continuous dynamical systems, controllability and observability. Canonical forms, irreducible realizations. Synthesis of compensators and observers. Composite systems, elements of stability. Prerequisite: ECE 308.

(3-0-3)

ECE 535

Discrete Time Systems

Discrete systems. Sampling and reconstruction procedures. Transform techniques of analysis and synthesis. State space techniques. Discrete controllability, observability and stability. Compensation and digital controllers. Prerequisite: ECE 438.

(3-0-3)

ECE 538

Renewable Energies

Various renewable energy sources such as solar systems, wind powered systems, ocean tides, ocean waves, and ocean thermal are presented. Their operational principles are addressed. Grid connected interfaces for such systems are explained. Research and simulation mini-projects with emphasis on either machine design, or power electronic circuit analysis, design, and controls, or grid connected renewable systems are assigned to student groups.

(3-0-3)

ECE 539

Computer Aided Design of Electric Machines

Fundamentals of energy conversion will be discussed, which are the foundation of efficient design and operation of motors and generators in modern day automotive, domestic, and renewable energy systems. It will further investigate the principles of structural assessment, electromagnetic analysis, dimensional, and thermal constraints. Finite Element Analysis (FEA) software-based design projects will be used to model the performance and operation of electric machines.

(3-0-3)

ECE 540

Reliability Theory and System Implementation

Basic probability and modeling techniques on component, subsystem and system levels. MTBF, MTTR and downtime. Hardware, software and cost considerations. Switching systems. Multicomputer and memory configurations.

Prerequisites: ECE 308 and MATH 474.

(3-0-3)

ECE 541

Performance Evaluation of Computer Networks

Introduction to performance evaluation techniques for computer and communication networks. Little's theorem, birth-death processes, M/G/1 queue, product form queueing networks, approximation techniques for G/G/1 queues and non-product form queueing networks. Discrete event simulations, generation of random variables, variance reduction techniques and general purpose simulation languages. Prerequisite: MATH 474.

(3-0-3)

ECE 542

Design and Optimization of Computer Networks

This course provides comprehensive introduction to network flows with an integrative view of theory, algorithms, and applications. It covers shortest path, maximum flow, and minimum cost flow problems, including a description of new and novel polynomial-time algorithms. It also covers topics from basic network design to protection and restoration design, to multi-layer network design while taking into account routing and flow requirement as applicable in different network architecture, protocol and technologies.

Prerequisite: ECE 407.

(3-0-3)

ECE 543

Computer Network Security

This course introduces network security by covering topics such as network-related security threats and solutions, private- and public-key encryptions, authentication, digital signatures, Internet Protocol security architecture (IPSEC), firewalls, network management, email and web security.

Prerequisite: ECE 407 .

(3-0-3)

ECE 544

Wireless and Mobile Networks

This course provides an overview of different wireless and mobile network standards and systems. The topics covered include cellular networks, satellite networks, wireless local area networks, wireless personal area networks, mobile IP, ad hoc networks, sensor networks, wireless mesh network and wireless network security. Prerequisites: Graduate standing, ECE 407 or ECE 408.

(3-0-3)

ECE 545

Advanced Computer Networks

Fundamentals of computer communication networks. Overview of data communication networks and protocol architectures with emphasis on the Internet protocols and network elements. Principles of network and protocol design; error detection and correction, flow control and congestion control, delay and throughput models, QoS, service support and application interface (including remote procedure call mechanisms). Local and Wide Area Networks (Ethernet, FDDI, Wireless LAN, ATM and Internet). LAN and WAN interconnection using bridges, routers, switches and gateways. Routing in data networks. Network and protocol design to support multimedia and multicasting connections. Network application security. Prerequisite: ECE 407 or ECE 408.

(3-0-3)

ECE 546

Wireless Network Security

This course focuses on selected research topics in current interests in wireless network security. This course will cover security and privacy issues in wireless systems, including cellular networks, wireless LAN, mobile and ad-hoc networks (MANET), wireless mesh networks, sensor networks, vehicular networks, RFID, and ubiquitous computing.

(3-0-3)

ECE 548

Energy Harvesting

Various harvesting techniques such as solar, ocean waves, vibration, linear motion, radio frequency, passive and active human power generation are presented. Their operational principles are addressed. Research and simulations mini-projects with emphasis on power electronic circuit analysis, design, and controls are assigned to student groups.

Prerequisite: ECE 311.

(3-0-3)

ECE 549

Motion Control Systems Dynamics

Fundamentals and applications of motion control systems, control techniques for high precision motion control, state variable feedback of linear and nonlinear systems, multivariable systems, physical system modeling, graphical analysis, and numerical analysis, and system performance analysis. Prerequisites: ECE 438 or permission of instructor.

(3-0-3)

ECE 550

Power Electronics Dynamics and Control

Modeling and analysis of solid-state switching circuits, parallel module dynamics, multi-converter interactions, resonant converters, feedback control, stability assessment, reduced parts converters, integrated structures, programmable switching regulators, digital switch-mode controllers, and power electronic converter-on-a-chip development.

Prerequisite: ECE 411.

(3-0-3)

ECE 551

Advanced Power Electronics

Advanced power electronic converters, techniques to model and control switching circuits, resonant converters, multi-level converters, Pulse-Width-Modulation (PWM) techniques, soft switching methods, and low-voltage high-current design issues are studied. Single-phase and multi-phase, controlled and uncontrolled rectifiers and inverters with different operating techniques and their design and control issues are explained. Prerequisite: ECE 411. (3-0-3)

ECE 552

Adjustable Speed Drives

Fundamentals of electric machines, basic principles of variable speed controls, field orientation theory, direct torque control, vector control of AC drives, induction machines, switched reluctance and synchronous reluctance motors, permanent magnet brushless DC drives, converter topologies of DC and AC drives, and sensorless operation. Prerequisite: ECE 411. (3-0-3)

ECE 553

Power System Planning

Model development. Interchange capability, interconnections, pooling. Economic generator size and site selection. Concept of reserves, transformers, relays and circuit breakers. Reactive planning AC and DC systems are explored thoroughly from a planning standpoint. Prerequisite: ECE 418 or ECE 419. (3-0-3)

ECE 554

Power System Relaying

Principles of relay protection for faults on transmission lines and in transformers, rotating machines and other equipment. Use of overcurrent, differential, distance, wire-pilot, carrier-pilot and microwave-pilot relaying systems. Solid-state relays and computer control of relaying. Determination of short-circuit currents and voltages from system studies. Prerequisite: ECE 418 or ECE 419. (3-0-3)

ECE 555

Power Market Operations

Market design in restructured power systems, artificial neural network applications to power systems, short-term load forecasting, electricity price forecasting, price-based unit commitment, arbitrage in electricity market, gaming and market monitoring, asset valuation and risk analysis, security-constrained unit commitment, ancillary services auction, transmission pricing and regional transmission organizations. Prerequisite: ECE 418 or ECE 419. (3-0-3)

ECE 556

Power Markets Economics and Safety

This course covers simulation and scheduling tools used in restructured power system for studying the economics and security of power systems. Topics include modeling of generating units (thermal units, combined-cycle units, fuel-switching/blending units, hydro units, pumped-storage units, photovoltaic, wind), Lagrangian Relaxation-based scheduling, mixed integer programming-based scheduling, and Benders decomposition-based transmission security analyses. The simulation and scheduling tools consider different time scales including on-line security, day-ahead, operational planning, and long-term. The simulation and scheduling tools consider interdependency of supply (such as gas, water, renewable sources of energy) and electricity systems. Prerequisites: ECE 420 or consent of instructor. (3-0-3)

ECE 557

Fault Tolerant Power Systems

Critical fault events in a large power system, sparsity techniques. Contingency screening process. Modeling of local controls in load flow. Adaptive localization method. Injection outage analysis. Security constrained dispatch. LP-based OPF. Real-time security analysis. Dynamic security analysis. Prerequisite: ECE 418 or ECE 419. (3-0-3)

ECE 558

Power System Reliability

The concept of reliability, reliability indices, component reliability, generation capacity reserve evaluation, transmission system reliability, bulk power system reliability, distributed system reliability, reliability modeling in context. Prerequisite: ECE 418 or ECE 419. (3-0-3)

ECE 559

High Voltage Power Transmission

Detailed analysis of transmission and distribution systems. Design of high voltage transmission lines and cables, as well as distribution lines. Flexible AC Transmission Systems (FACTS) and high voltage DC links. Prerequisite: ECE 418 or ECE 419. (3-0-3)

ECE 560

Power System Dynamics and Stability

The transient stability problem, acceleration equations, stability criteria, two-machine and multi-machine problems. Perturbation analysis, eigenvalue sensitivity, Liapunov theory and application to power systems stability. Prerequisite: ECE 418 or ECE 419. (3-0-3)

ECE 561

Deregulated Power Systems

Overview of key issues in electric utilities restructuring, Poolco model, bilateral contracts, market power, stranded costs, transmission pricing, electric utility markets in the United States and abroad, OASIS, tagging electricity transactions, electric energy trading, risk in electricity markets, hedging tools for managing risks, electricity pricing, volatility in power markets, RTO. Prerequisite: ECE 418 or ECE 419. (3-0-3)

ECE 562

Power System Transaction Management

Power interchange transaction management in the deregulated electric power industry. Course topics include power system security assessment, total and available transfer capability (TTC/ATC), transaction management system (TMS), transaction information system (TIS), tagging, interchange distribution calculator (IDC), congestion management, transmission loading relief (TLR). Prerequisite: ECE 418 or ECE 419. (3-0-3)

ECE 563

Computational Intelligence in Engineering

Introduction to soft computing, fuzzy set theory, neural networks, genetic algorithms, intelligent software agents, comparisons with traditional alternatives, advanced engineering applications. Prerequisite: Graduate standing. (3-0-3)

ECE 564

Control and Operation of Power Systems

Unit commitment and application of dynamic programming, fuel budgeting and planning, probabilistic production cost modeling, hydrothermal coordination, power system security and application of expert systems, state estimation, optimal power flow, interchange evaluation and power pools, reactive power planning. Prerequisite: ECE 418 or ECE 419. (3-0-3)

ECE 565

Computer Vision and Image Processing

Multi-dimensional signal sampling and discrete Fourier transform; Image segmentation; Object boundary (edge) detection and description; Shape representation and extraction; Matching and recognition; Image registration; Camera geometry and stereo imaging; Morphological processing; Motion detection and compensation; Image modeling and transforms; Inverse problems in image processing (restoration and reconstruction). Prerequisite: ECE 437 and MATH 474. (3-0-3)

ECE 566

Statistical Pattern Recognition

Review of appropriate math: multidimensional probability, covariance matrices, whitening transformation, diagonalization, eigenvectors, eigenvalues. Two-class and multi-class pattern separation using maximum likelihood and MAP. Linear discriminant analysis. Perception algorithm and its extensions. Feature extraction algorithms. Clustering algorithms. Introduction to neural nets. Hopfield, Hamming, feedforward models. Training of neural nets. Prerequisite: ECE 511. (3-0-3)

ECE 567

Statistical Signal Processing

Detection theory and hypothesis testing. Introduction to estimation theory. Properties of estimators, Gauss-Markov theorem. Estimation of random variables: conditional mean estimates, linear minimum mean-square estimation, orthogonality principle, Wiener and Kalman filters. Adaptive filtering. LMS algorithm: properties and applications. Prerequisites: ECE 511, MATH 333. (3-0-3)

ECE 568

Digital Speech Processing

Review of discrete statistical signal analysis. Acoustic aspects of speech and hearing. Digital models of speech production. Short-time processing in time and frequency domains. Waveform encoding and linear predictive coding of speech. Estimation of fundamental speech parameters. Applications including automatic speech recognition and enhancement. Prerequisites: ECE 437, ECE 511. (3-0-3)

ECE 569

Digital Signal Processing II

Review of basic DSP theory. Design of digital filters: FIR, IIR, frequency transformation methods, optimal methods. Discrete Fourier Transform (DFT) and Fast Fourier Transform algorithms. Spectral estimation techniques, classical and parametric techniques. AR, MA, ARMA models. Estimation algorithms. Levinson, Durbin-Levinson and Burg's algorithms. Eigenanalysis algorithms for spectral estimation. Prerequisites: ECE 437 and MATH 474. (3-0-3)

ECE 570

Fiber Optic Communication Systems

Physics of optical fiber, composition, dimensioning, coupling, attenuation, dispersion. Electro-optical conversion devices (ILDs, LEDs, APDs, PINs). Circuit considerations. Modulation techniques and implications. Overall system considerations. Coherent techniques. Prerequisites: ECE 307, ECE 309, ECE 312, ECE 403. (3-0-3)

ECE 571

Nanodevices and Technology

Electronic properties and quantum effects; Dielectric, magnetic and optical properties and their characterizations; Individual nanoparticles and clusters; Carbon nanotubes; Solid disordered nanostructures; Nanostructured crystals; Quantum wells, wires and dots; Giant magnetoresistance; Material processing techniques; Devices and systems based on nanostructures. Prerequisites: B.S. degree with knowledge of quantum mechanics and thermodynamics. (3-0-3)

ECE 575

Electron Devices

Electronic properties of solids. Properties of p-n junctions and junction devices. Gunn diode and IMPATT devices. Junction transistors. Schottky diode and MESFET. The MOS capacitor and MOSFET. Lightemitting diodes and junction lasers. Velocity modulation and bunching in electron beams. Klystrons, magnetrons and other microwave thermionic devices. Prerequisites: ECE 307, ECE 312. (3-0-3)

ECE 576

Antenna Theory

Plane and spherical waves. Electric and magnetic dipoles. Radiation patterns and impedance characteristics of antennas in free space and over perfect ground. Linear and planar driven antenna arrays. Yagi-Uda parasitic arrays. Prerequisites: ECE 307, ECE 421 or ECE 423. (3-0-3)

ECE 578

Microwave Theory

Microwave field theory. Propagation, reflection and refraction of plane waves. Anisotropic media. Impedance concept. Hollow, surface-wave and dielectric wave guides. Discontinuities in wave guides. Microwave resonators. Transmission lines. Microwave circuit theory. Prerequisite: ECE 421 or ECE 423. (3-0-3)

ECE 580

Elements of Sustainable Energy

This course covers cross-disciplinary subjects on sustainable energy that relate to energy generation, transmission, distribution, and delivery, as well as theories, technologies, design, policies, and integration of sustainable energy. Topics include wind energy, solar energy, biomass, hydro, nuclear energy, and ocean energy. Focus will be on the integration of sustainable energy into the electric power grid, the impact of sustainable energy on electricity market operation, and the environmental impact of sustainable energy. (3-0-3)

ECE 581

Elements of Smart Grid

This course covers cross-disciplinary subjects on smart grids that relate to energy generation, transmission, distribution, and delivery, as well as theories, technologies, design, policies, and implementation of smart grid. Topics include: smart sensing, communication, and control in energy systems; advanced metering infrastructure; energy management in buildings and home automation; smart grid applications to plug-in vehicles and low-carbon transportation alternatives; cyber and physical security systems; microgrids and distributed energy resources; demand response and real-time pricing; and intelligent and outage management systems. (3-0-3)

ECE 583

High Speed Computer Arithmetic

This course covers computer arithmetic as applied to general-purpose and application-specific processors. The focus is on developing high-speed arithmetic algorithms and understanding their implementation in VLSI technology. Topics include fixed and floating point number systems, algorithms and implementations for addition, subtraction, multiplication, division, and square root, floating point operations, elementary function approximation, low-power design, error analysis, and interval arithmetic. Prerequisites: ECE 446 or ECE 485. (3-0-3)

ECE 584

VLSI for Signal Processing and Communications

This course aims to convey knowledge of advanced concepts in VLSI signal processing. Emphasis is on the architectural research, design and optimization of signal processing systems used in telecommunications, compression, encryption and coding applications. Topics covered include the principles of datapath design; FIR and IIR filtering architectures; communication systems including OFDM, multirate signal processing; fast transforms and algorithms including fast Fourier Transform; Discrete Cosine Transform; Walsh-Hadamard Transform; and Wavelet kernels. Furthermore, advanced computer arithmetic methods including Galois Fields, CORDIC, residue number systems, distributed arithmetic, canonic signed digit systems and reduced adder graph algorithms are examined. Prerequisite: ECE 429 and ECE 437. (3-0-3)

ECE 585

Advanced Computer Architecture

Design, Analysis and Performance of High-Performance Computer Architectures; High Speed memory Systems; Cache Design and Analysis; Modeling Cache Performance; Instruction Level Parallelism, Cacheonly Memory Architectures, Classification of Parallel Architectures; Systolic and Data Flow Architectures; Multiprocessor Performance; and Multiprocessor Interactions. Prerequisite: Graduate standing or faculty consent. (3-0-3)

ECE 586

Fault Detection in Digital Circuits

Essential elements in testing and testability of digital designs. Automatic test generation algorithms and fault-simulation methods. Design methodologies to increase testability and decrease test generation costs. Techniques for built-in testing. Prerequisite: ECE 446. (3-0-3)

ECE 587

Hardware and Software Co-Design

Computer-aided techniques for the joint design of hardware and software: specification, analysis, simulation and synthesis. Hardware/software partitioning, distributed system cosynthesis, application-specific instruction set design, interface cosynthesis, timing analysis for real-time systems. Prerequisites: CS 201, ECE 441, graduate standing. (3-0-3)

ECE 588

CAD Techniques for VLSI Design

Overview of techniques and algorithms used in Computer-Aided Design (CAD) for VLSI circuits. Physical CAD tools, including placement, routing, symbolic layout and compaction. High-level CAD tools, including logic synthesis, silicon compilers and high-level synthesis. Recent developments in the field. Design, implementation and performance analysis of prototype CAD tools. Prerequisite: ECE 429. (3-0-3)

ECE 589

Computer Aided Design of Analog IC

Analog IC design optimization algorithm such as equation-based optimization and simulation-based optimization algorithms, design automation tools such as harmonic balance, projection-based surface response estimation, shooting methods, etc. will be introduced. Research and mini-projects with emphasis on analog integrated circuit design and optimization algorithms using state-of-the-art tools are assigned to student groups. Prerequisite: Graduate standing. (3-0-3)

ECE 591

Research and Thesis for M.S. Degree

ECE 594

Special Projects

ECE 597

Special Problems

Undergraduate Courses Available to Graduate Students

ECE 401

Communication Electronics

ECE 403

Digital and Data Communication Systems

ECE 405

Digital and Data Communication Systems with Laboratory

ECE 407

Introduction to Computer Networks with Laboratory

ECE 408

Introduction to Computer Networks

ECE 411

Power Electronics

ECE 412

Electric Motor Drives

ECE 417

Power Distribution Engineering

ECE 418

Power Systems Analysis

ECE 419
Power Systems Analysis with Laboratory

ECE 420
Analytical Methods in Power Systems

ECE 421
Microwaves

ECE 423
Microwave Circuits and Systems

ECE 425
Analysis and Design of Integrated Circuits

ECE 429
Introduction to VLSI Design

ECE 436
Digital Signal Processing with Laboratory

ECE 437
Digital Signal Processing

ECE 438
Control Systems

ECE 441
Microcomputers

ECE 446
Advanced Logic Design

ECE 449
Object-Oriented Programming and Computer Simulation

ECE 481
Image Processing

ECE 485
Computer Organization and Design