Electrical Engineering

Department of Electrical Engineering

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Overview

The electrical engineering field is built on the shoulders of giants to meet the energy (Tesla, Edison and others) and telecommunication (Marconi, Bell and others) needs of our society. Out of the advancements in electronics and photonics technology, Electrical Engineering is everywhere around us nowadays (almost everything we use in our daily lives has a chip in it and implements some communication protocol and/or some sophisticated signal processing algorithm). Electrical Engineers provide energy solutions to light our homes; design, analyze and optimize wireless communication devices and networks that revolutionize the way we live (e.g. cellular phones, wireless networks, GPS, electronic commerce, smart rooms); advance underwater communication technologies for monitoring/sensing oceanic environmental changes; design smart software radio systems and networking protocols to facilitate ubiquitous terra-bit volume multimedia communications; develop biomedical devices and instrumentation to saves lives; use nanotechnology to produce better, faster, brighter, and stronger materials for solar cells and sensing devices; design the technology that enables customized multimedia entertainment; advance new green technologies that will power our future while protecting the environment. Electrical engineers can be found in almost all sectors of the work force, including research and development, product design, manufacturing, operations, service, technical sales, marketing, consulting, education, and policy making.

The undergraduate degree offered by the Department is the Bachelor of Science in Electrical Engineering (BSEE). The program provides the scope of knowledge and training needed for employment and also forms the basis for further study at the graduate level.

Electrical Engineering Program Educational Objectives
Our graduates shall:

- Demonstrate expertise and career advancement in their field through the application of fundamental knowledge (mathematics and science), skills (problem solving), and engineering tools
- communicate effectively by delivering presentations, patent applications, reports, and/or scholarly conference and journal papers
- contribute to the achievement of their organization's goals as an effective leader and/or effective team member
- be engaged in their profession and life-long learning by using their knowledge and expertise to aid civic institutions, educational organizations, and professional societies.

The program is designed to serve both students who intend to enter industry directly and others who plan to continue their education through formal graduate study.

About our Degrees

The electrical engineering BS degree is accredited by the Accreditation Board for Engineering and Technology (ABET) and prepares students for graduate study and/or professional practice.

Acceptance Criteria - BS
See the Degrees and Policies section of the School of Engineering and Applied Sciences entry in the Undergraduate Catalog for accceptance information.

Students can select EE as a major if they are students in good standing within the School of Engineering and Applied Sciences, or when they apply to UB. Non-engineering students seeking to change their major to EE should first apply and be admitted by the School of Engineering and Applied Sciences.

Acceptance Information - BS/MBA

Must have good standing as an Electrical Engineering undergraduate student and be admitted as a graduate student by the School of Management.

Degree Requirements

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Students must meet minimum GPA and residency requirements as specified by the Dean of the School of Engineering and Applied Sciences to graduate from the program. See the Degrees and Policies section of the School of Engineering and Applied Sciences entry in the Undergraduate Catalog for academic requirements.

Please see Degrees and Policies.

About our Courses

The BS curriculum includes math, science, and basic engineering courses in the freshman and sophomore years, required electrical engineering courses in the junior and senior years, and technical elective courses in the senior year. As there are many similarities during the first year of all engineering disciplines' curricula, students can transfer among engineering majors fairly easily in the freshman year. Students have considerable flexibility in the selection of technical elective courses, allowing them to specialize in an electrical engineering sub-discipline. Also available to interested students are several work-experience courses (internships and engineering co-op).

Suggested Introductory Courses

- EAS 140 Engineering Principles
- EAS 202 Engineering Impact on Society
- EE 101 Basic Electronics
- CHE 107 General Chemistry for Engineers
- EE 202 Circuit Analysis
- MTH 141-MTH 142 College Calculus I - II
- PHY 107-PHY 108 General Physics I - II

The typical class size for:

Freshman/introductory courses is: 100
Sophomore/intermediate courses is: 50-80
Upper level/advanced courses is: 10-30

In the Department of Electrical Engineering, what do teaching assistants (TAs) do?

Teaching Assistants (TAs) assist professors in all courses with laboratory and recitation sections. They frequently lead small-group discussion sections and may also assist with grading.

For course descriptions, please see Courses.

About our Faculty

Faculty functions
Faculty in a research university like UB, have three major responsibilities: (i) teach and advise students, (ii) perform scientific research and (iii) serve the university community, the broader local community and their professional national/international community. While teaching and student advising are somewhat traditional activities of a professor, scientific research endeavors are particularly significant in a research university. Research is what advances science and technology. Professors who are active/accomplished researchers contribute significantly to student education by bringing to the classroom knowledge of the state of the art in science and technology. This is a unique attribute to research universities and the opportunity to having access to such professors is a great educational asset for all students.
To facilitate their research endeavors professors write and submit proposals to federal (e.g. National Science Foundation, Department of Defense, National Institutes of Health etc.), state, and private/industry agencies and organizations requesting financial support. Requested amounts vary from a few thousands to several millions of dollars. The selection process is very competitive. The success rate in having a proposal funded (funded proposals are called grants) may well be less that 5%. These research funds are used primarily to pay the stipend and tuition of undergraduate and graduate students who serve as research assistants and are hired by professors to directly work on a project, buy equipment/materials needed for the project, cover travel expenses for faculty and students to disseminate their findings in national and international scientific meetings. In addition to teaching and research, professors serve their scientific community as editors of scientific journals, reviewers of scientific manuscripts and research proposals of their peers.
The director of undergraduate studies, Pao-Lo Liu, can be reached at 716.645.1021 or paololiu@buffalo.edu.

Faculty Specializations
Our faculty members specialize in four research areas: Energy Systems, Optics and Photonics, Signals, Communications and Networking, and Solid State Electronics. Faculty interests usually fall in more than one focus area. In our working environment faculty within discipline share spaces/labs, have joint research projects that lead to joint publications and student advising. Faculty also collaborate across disciplines (some faculty even hold joint appointments with other departments). More specifically, faculty research in the area of Energy Systems focuses on power systems and infrastructure, energy utilization and distribution, smart grid, energy markets and economics, mobility platforms, nano-dielectrics, batteries for implantable devices, renewables, photovoltaics. Faculty research interests in the area of Optics and Photonics

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include photonic materials and devices, hybrid inorganic / organic materials & devices, biophotonics, nanophotonics, metamaterials, nonlinear and fiber optics, nano-optics, nanoplasmonics, bio sensing and environmental sensing, optofluidics, biomagnetics, bioseparation, drug targeting. Faculty research interests in the area of Signals Communications and Networking include wireless multiuser communications, compressed sensing, multimedia and underwater sensor networks, covert communications, RF security, spread-spectrum communications, waveform design, cognitive radio networks, game theory and optimization of wireless systems, cooperative communications, MIMO communications, resource allocation and scheduling of multimedia networks, video communications, magnetic resonance imaging, radar imaging, small sample support adaptive signal processing, channel coding. Research interests in the area of Solid State Electronics include nanoelectronics, microelectronics, nanomaterials characterization, teraHertz applications, thermoelectronic and optoelectronic devices, nanostructured semiconductor devices, ultra-high frequency GaN devices, transport & device physics in semiconductor heterostructures, analog VLSI, electronic routing & packaging, electron beam lithography, smart sensors, semiconductor device simulation.

More information can be found at http://www.ee.buffalo.edu/people/full_time.php for descriptions of the specializations of our faculty.

Faculty Awards
Our faculty members have received over the years major awards at both national and international level as well as several state, SUNY-wide and UB distinctions. The list of such awards and distinctions includes: National Medal of Technology , National Academy of Engineering, SUNY Distinguished Professor, National Inventors Hall of Fame, SUNY Chancellor's Award for Excellence in Teaching, UB Exceptional Scholar Awards for Sustained Achievement, Fellows of Technical/Professional Societies (American Physics Society, the Institute of Electrical and Electronics Engineers, the Optics Society of America, and the American Association for the Advancement of Science), Presidential Young Investigator Award, NSF CAREER Award, Office of Naval Research Young Investigator Award, Prolific Inventor Award, Best Paper Awards (for research contributions in international scientific journals). Other awards received by our faculty include Tau Beta Pi Teacher of the Year award, Milton Plesur Excellence in Teaching Award, the UB Teaching Innovation Award, UB Award for Excellence in Student Mentoring, a Wilson Greatbatch Professorship for Advanced Power Sources.

See a list of our Undergraduate Faculty.

About our Facilities

Many electrical engineering courses take advantage of UB's technology equipped classrooms. The Department of Electrical Engineering provides its students with a computing laboratory equipped with state of the art software, as well as recently upgraded teaching laboratories for electronic circuit design and analysis. The Department is located in the new Barbara and Jack Davis Hall. Davis Hall includes a 5,000 square foot, grade 1,000, clean room facility that enables research in nanotechnology with state-of-the art equipment that allows for photolithography, metal deposition and dry chemical etching. The list of research laboratories in Davis Hall includes: Testing and Characterization Lab, SMALL (Sensors + Microactuators Learning Lab), Electronic Materials Lab, Wireless Communication Systems and Networks Lab, Secure Communications Lab, Analog VLSI and Sensors Laboratory, Advanced Spectroscopic Evaluation Laboratory, Nanophotonics and Nonlinear Optics Lab, Underwater Communications and Networking Lab, Signal Processing and Communication Electronics Lab, Advanced Power Sources Lab, Cognitive Communications and Networking, Nano-Optics and Biophotonics, Advanced Spectroscopic Evaluation Laboratory, Analog VLSI and Sensors Laboratory. A state-of-the art auditorium and several conference rooms facilitate day-to-day meeting needs of faculty and students.

Acceptance Information

For acceptance information please see the Degrees and Policies section of the School of Engineering and Applied Sciences entry in the Undergraduate Catalog.

Transfer Policy

Transfer students must first apply to the university and meet the university transfer admission requirements before consideration for admission to the Department of Electrical Engineering. Electrical engineering courses completed at other colleges and offered as substitutes for UB courses are evaluated individually by the EE Undergraduate Curriculum Committee. A determination is made by an evaluation of the student's transcripts, course content, contact hours, and grades earned. Most courses taken from an ABET accredited college level electrical engineering department are transferable. Evaluations for transfer credits of general education, basic science, and engineering science courses completed at other universities and colleges are done through the Office of Undergraduate Education, School of Engineering and Applied Sciences, 410 Bonner Hall. For more information, see School of Engineering and Applied Sciences.

Extracurricular Activities

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Our undergraduate students are active in student chapters of many national professional societies, including:

- Student Chapter, Eta Kappa Nu (EKN)
- Student Chapter, Engineers for a Sustainable World (ESW)
- Student Chapter, Institute of Electrical and Electronics Engineers (IEEE)
- Student Chapter, Society of Hispanic Professional Engineers (SHPE)
- Student Chapter, Society of Women Engineers (SWE)
- Student Chapter, Tau Beta Pi (TBP)
- UB Robotics (UBR)

See the UB Student Association.

Practical Experience and Special Academic Opportunities

Undergraduate Research
As part of their undergraduate education, students are encouraged to participate in research opportunities. Undergraduate research experiences are sometimes available for course credit, pay or on a volunteer basis. The Center for Undergraduate Research and Creative Activity (CURCA) serves as a clearing house for information regarding undergraduate research opportunities. There are many opportunities advertised via CUCRA for undergraduate research with faculty that can provide the opportunity to participate in research projects and in pertinent publications or presentations. Research activities may also be arranged directly between students and faculty members within the Department of Electrical Engineering. Students may complete a senior thesis on their research, if appropriate.

Study Abroad
Electrical Engineering majors can consider spending a summer, a semester or a year studying abroad. Study abroad programs are available to juniors, seniors and graduate students. During a study abroad semester, students usually pay tuition at the home institution (UB). Students can take courses abroad at the following institutions which either have already established an exchange program or are at the final stages of establishing a program:
(i) ENSEA in Cergy-Pontoise, France, 40 minutes from Paris (courses in English)
(ii) Chalmers University of Technology, Sweden, located in the beautiful city of Gothenburg (courses in English)
(iii) Universidade Federal de Santa Catarina, Universidade Federal do Rio Grande do Norte, Universidade Federal do Rio Grande do Sul, Brazil (courses in Portuguese)
(iv) Telecom SudParis, France, located in Paris (courses in English)
(v) University of Rome, la Sapienza, Italy, located in Rome (courses in English)
(vi) Polytechnic University of Valencia, Spain, located in Valencia (courses in English)

International Program coordinator: Tommaso Melodia (tmelodia@buffalo.edu).

Internships and Co-op Opportunities
Work experience is available through the Engineering Career Institute program in the School of Engineering and Applied Sciences. The Engineering Career Institute offers a junior-level course, EAS 396, 1 cr, that covers career-effectiveness skills. This course may be followed by co-op work experience (EAS 496, credit hours variable).

Honors, Awards, and Scholarships
A number of students in the Department are awarded scholarships annually. Some of the scholarships are nationally competitive, such as the Barry M. Goldwater Scholarship. Other scholarships are department specific. These include the David M. Benenson Memorial Scholarship, the Joan G. Bennett Memorial Scholarship, the D. Richard Ferguson Memorial Scholarship, the United Illuminating Scholarship and Internship Award, and the James J. Whalen Memorial Scholarship. Students are also eligible for scholarships from the School of Engineering and Applied Science or the University. These may include American Council of Engineering Companies of New York Scholarship, Association of Old Crows (AOC) Scholarships, CSX Transportation Scholarship, Engineering Alumni Association Scholarships, Engineering Undergraduate Fellowships, James W. and Nancy A. McLernon SAE Engineering Scholarship, Presidential Fellowships, Schomburg Fellowship Senior Scholar Awards, Felix Smist Scholarship, Elbridge N. and Stephana R. Townsend Scholarship, and Watts Engineering and Architecture Minority Scholarship. Students interested in more information should contact the Director of Undergraduate Studies.

Independent Study
Approval is required to take EE 499 Independent Study as a senior technical elective.

Career Information and Further Study

Electrical engineers are involved in a broad spectrum of challenging activities, such as research and development, product design, manufacturing, operations, service, technical sales, marketing, consulting, education, and policy making. More specifically, Electrical Engineers provide energy solutions to light our homes; design, analyze and optimize wireless communication devices and networks that revolutionize the way we live (e.g. cellular phones, wireless networks, GPS, electronic commerce, smart rooms); advance underwater communication technologies for monitoring/sensing oceanic environmental changes; design smart software radio systems and networking protocols to facilitate ubiquitous terra-bit volume multimedia communications; develop biomedical devices and instrumentation to saves lives; use nanotechnology to

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produce better, faster, brighter, and stronger materials for solar cells and sensing devices; design the technology that enables customized multimedia entertainment; advance new green technologies that will power our future while protecting the environment. Electrical engineers can be found in almost all sectors of the work force. Electrical Engineering is everywhere around us nowadays (almost everything we use in our daily lives has a chip in it and implements some communication protocol and/or some sophisticated signal processing algorithm).

Alumni in Electrical Engineering have found employment in the following fields:
Academia
Circuit design
Communications
Consulting
Department of Defense (Air Force, Army, Navy)
Education
Electrical systems
Environmental protection
Maintenance
Management
Manufacturing
Medical electronics and imaging
Multimedia industry
Nanotechnology
Operation of technical systems
Patent application and review
Public policy
Power engineering
Product design
Radar Imaging
Research and development
Service
Signal Processing Industry
Specialized software design (e.g. software radios)
Technical sales and marketing
Teaching and education
Venture capital investment
Video Technology
Wireless Communications and Networking Industry

Salary Information

Starting Salary for a BS in Electrical/electronics/communications is $60,125 according to Department of Labor 2009 data.
Factors influencing salary: Skills, experience, internship, project and design experience, geographic location, and size of company.
For electrical engineers in mid-career, the 25-75% range is $83,800 - $130,000.
Educational level influence on salary:
The average starting salary for a graduate with a master's degree is $71,455. For a graduate with a PhD, the average starting salary is $88,893.

What percentage of graduates goes on to graduate school?

25%

What percentage of graduates goes on to find related employment?

75%

Formal system of tracking graduates?

The department tracks graduates and communicates with them. Tracking is done by the School of Engineering & Applied Sciences Alumni Association.

Professional Society

Our professional society is the Institute of Electrical and Electronics Engineers (IEEE). IEEE is the largest technical professional society with over 2.0 million technical articles, more than 144 journals and magazines and a total membership of 382,400 members with the following age distribution: 21.69% under 30 yrs, 18.3% in the range of 30-39 yrs, 23% in the range of 40-49 yrs, 19.2% in the range of 50-59 yrs, 10.8% in the range of 60-69 yrs, and 7.1% over 70 yrs.

Degree Options

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The Department of Electrical Engineering offers a BS degree in Electrical Engineering and a combined degree program that leads to two degrees: a BS in Electrical Engineering and a MBA in Business Administration.

Degrees Offered

Undergraduate: BS
Combined: BS/MBA
Graduate: MS, MEng, PhD

Links to Further Information About this Program

- Undergraduate Catalog
- Undergraduate Admissions
- Graduate Admissions
- Department of Electrical Engineering
- School of Engineering and Applied Sciences

Electrical Engineering - B.S.

Acceptance Criteria

For acceptance information please see the Degrees and Policies section of the School of Engineering and Applied Sciences entry in the Undergraduate Catalog.

Required Courses

CHE 107 General Chemistry for Engineers
CSE 379 Introduction to Microprocessors and Microcomputers
CSE 380 Introduction to Microprocessors Lab
EAS 140 Engineering Principles
EAS 202 Engineering Impact on Society
EAS 230 Engineering Computation
EAS 305 Applied Probability
EE 101 Basic Electronics or one technical elective
EE 202 Circuit Analysis
EE 205 Signals and Systems
EE 278 Digital Principles
EE 310 Electronic Devices and Circuits I
EE 311 Electronic Devices and Circuits II
EE 324 Applied Electromagnetics
EE 352 Introduction to Electronics Lab
EE 353 Electronic Circuits Lab
EE 383 Communication Systems
EE 408 Senior Seminar
EE 409 Senior Design Implementation
EE 436 Fundamentals of Energy Systems
MTH 141 College Calculus I
MTH 142 College Calculus II
MTH 241 College Calculus III
MTH 306 Introduction to Differential Equations
PHY 107 General Physics I
PHY 108 General Physics II
PHY 158 General Physics II Lab
PHY 207 General Physics III
PHY 257 General Physics III Lab
Two restricted upper-division technical electives
Three unrestricted upper-division technical electives
One free elective

Summary
Total required credit hours for the major: 108

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See Baccalaureate Degree Requirements for general education and remaining university requirements.

Recommended Sequence of Program Requirements

FIRST YEAR
Fall CHE 107, EAS 140, MTH 141
Spring EE 101, MTH 142, PHY 107, EAS 202

SECOND YEAR
Fall EE 202, EE 278, MTH 306, PHY 108/PHY 158
Spring EAS 230, EE 205, MTH 241, PHY 207/PHY 257

THIRD YEAR
Fall EAS 305, EE 310, EE 324, EE 352
Spring CSE 379, CSE 380, EE 311, EE 353, EE 383

FOURTH YEAR
Fall EE 408, EE 436, two technical electives, one free elective
Spring EE 409, three technical electives

Electives and Course Groupings

Elective Courses
EE 401 RF and Microwave Circuits I
EE 403 Introduction to Plasma Processing
EE 410 Electronic Instrumentation Design
EE 412 Nanophontics
EE 413 Communication Electronics
EE 415 Microelectromechanical Systems
EE 416 Signal Processing Algorithms
EE 418 Quantum Mechanics for Engineers: First Course in Nanoelectronics
EE 419 Industrial Control Systems
EE 421 Semiconductor Materials
EE 422 Nanomaterials
EE 423 Nanotechnology and Science
EE 425 Electrical Devices I
EE 428 BioMEMS and Lab-on-a-Chip
EE 429 Introduction to Electromagnetic Compatibility
EE 430 Fundamentals of Solid State Devices
EE 435 Java Applet Modeling for Visual Engineering Simulation
EE 438 Electrochemical Power Sources: Design, Function, and Selection
EE 448 Microelectronic Device Fabrication
EE 449 Analog Integrated Circuit Layout
EE 453 Microelectronic Fabrication Lab
EE 455 Photonic Devices
EE 456 RF and Microwave Circuits II
EE 460 Current Research Topics of Power Modulation Applications
EE 462 Principles of Medical and Radar Imaging
EE 465 Current Research Topics of Pulsed Power Applications
EE 467 Integrated Power Electronics
EE 471 Sustainable Energy Systems
EE 476 High-Voltage Engineering
EE 478 Digital Design
EE 480 Biomedical Electronics
EE 482 Power Systems Engineering I
EE 484 Communications Systems II
EE 488 Fundamentals of Modern VLSI Devices
EE 489 Lasers and Photonics
EE 490 Consumer Optoelectronics
EE 491 Analog Circuits

Electrical Engineering Requirements
A total of five upper-division technical electives and one free elective are required.

At least two upper-division technical electives must be chosen from EE courses; CSE courses; MAE 340 Systems Analysis; MAE 443 Continuous Control Systems; or MAE 444 Digital Control Systems.

Three of the upper-division technical electives are unrestricted.

For students entering prior to fall 2011 please refer to the undergraduate catalog from the year you entered the university.

Electrical Engineering/Business Administration - B.S / M.B.A

Acceptance Criteria

Good standing as an electrical engineering undergraduate student and acceptance as a graduate student by the School of Management.

Advising Notes

The internship may be taken the previous summer to lighten the load in the fifth year.

Required Courses

CHE 107 General Chemistry for Engineers
CSE 379 Introduction to Microprocessors and Microcomputers
CSE 380 Introduction to Microprocessors Lab
EAS 140 Engineering Principles
EAS 202 Engineering Impact on Society
EAS 230 Engineering Computation
EAS 305 Applied Probability
EE 101 Basic Electronics or one technical elective
EE 202 Circuit Analysis
EE 205 Signals and Systems
EE 278 Digital Principles
EE 310 Electronic Devices and Circuits I
EE 311 Electronic Devices and Circuits II
EE 324 Applied Electromagnetics
EE 352 Introduction to Electronics Laboratory
EE 353 Electronic Circuits Laboratory
EE 383 Communication Systems
EE 408 Senior Seminar
EE 409 Senior Design Implementation
EE 436 Fundamentals of Energy Systems
MGA 603 Financial Accounting for Managers
MGA 605 Accounting for Management Decision Making
MGB 610 Organizational Behavioral
MGB 611 Team Skills
MGE 604 Business Economics
MGF 611 Financial Analysis for Manages
MGG 601 Corp Soc Resp/Sustainability
MGG 635 Management Communication
MGM 615 Marketing for Managers
MGO 620 Operations Management
MGO 640 Business Strategy
MGO 642 Integration of Business Functions
MGO 644 Business Practice
MGQ 608 Statistical Analysis for Managers
MGQ 609 Analytics for Managers
MGS 605 IT Management
MTH 141 College Calculus I
MTH 142 College Calculus II
MTH 241 College Calculus III
MTH 306 Introduction to Differential Equations
PHY 107 General Physics I
PHY 108 General Physics II
PHY 158 General Physics II Lab
PHY 207 General Physics III
PHY 257 General Physics III Lab
Two electrical engineering technical electives
MGT Electives - may include internship

Summary
Total required credits for the undergraduate portion: 95
Total required credits for the BS/MBA: 143

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See Baccalaureate Degree Requirements for general education and remaining university requirements.

Refer to the School of Management's MBA handbook for requirements for MBA candidates.

Recommended Sequence of Program Requirements

FIRST YEAR
Fall CHE 107, EAS 140, MTH 141
Spring EAS 202, EE 101, MTH 142, PHY 107

SECOND YEAR
Fall EE 202, EE 278, MTH 306, PHY 108, PHY 158
Spring EAS 230, EE 205, MTH 241, PHY 207/PHY 257

THIRD YEAR
Fall EAS 305, EE 310, EE 324, EE 352
Spring CSE 379, CSE 380, EE 311, EE 353, EE 383

FOURTH YEAR
Fall EE 436, MGA 603, MGB 610, MGB 611, MGF 611, MGG 601, MGG 635, MGM 615, MGQ 608, MGQ 609
Spring EE/CSE technical elective, MGA 605, MGE 604, MGO 620, MGO 640, MGS 605, MGT elective

FIFTH YEAR
Fall EE/CSE technical elective, EE 408, MGT electives
Spring EE 409, MGO 642, MGO 644, MGT electives

Electives and Course Groupings

Electrical Engineering Technical Electives (minimum 6 credits)

A total of two technical electives are required. These upper-division technical electives must be chosen from EE courses or CSE courses.

Contact the Department of Electrical Engineering for elective options.

For students entering prior to fall 2011 please refer to the undergraduate catalog from the year you entered the university.

A BS diploma and an MBA diploma are awarded upon completion, with a transcript notation that these degrees were awarded as part of a combined degree program.

EE 101: Basic Electronics

Credits: 3
Semester(s): Spring
Type: LEC/LAB

Introductory electronics course for engineering and science majors. Emphasizes analog and digital electronic systems organization, data acquisition, and signal transmission. A laboratory once a week illustrates these techniques by specific circuit devices.

EE 200: Electrical Engineering Concepts/Non-Majors

Credits: 3
Pre-requisites: PHY 108 or PHY 118
Co-requisites: MTH 306
Approved Engineering Majors Only
Type: LEC/REC

Introduces aspects of electrical engineering useful to all the engineering disciplines. Course material includes basic circuit analysis and networks, frequency response, elementary solid-state electronics, digital circuits, and energy conversion and transmission. Not intended for electrical or engineering physics majors. Students may not receive credit for this and EE 202.

EE 202: Circuit Analysis I

Credits: 4
Semester(s): Fall, Spring
Type: LEC/REC

Systematic development of network analysis methods. Topics include resistive circuits, Kirchhoff's laws, equivalent subcircuits; dependent sources; loop and nodal analysis; energy-storage elements; transient analysis of first-order and second-order circuits; sinusoidal steady-state analysis; passive filters.

EE 203: Circuit Analysis II

Credits: 4
Semester(s): Fall, Spring
Pre-requisites: EE 202; Approved Electrical Engineering,

Computer Engineering, or Engineering Physics Major
Type: LEC/REC

A continuation of EE 202. Brief review of basic concepts of time-domain circuit analysis; phasor analysis of steady-state ac circuits; complex power and three-phase systems; Laplace transform techniques and 's-domain' circuit analysis; transfer function; linear circuit design. Selected problem assignments and a final design project require use of circuit analysis software tools.

EE 205: Signals and Systems

Credits: 4
Pre-requisites: EE 202
Approved Electrical Engineering or Computer Engineering Major
Type: LEC/REC

Introduction to signals and systems; time-domain system analysis with the convolution integral; frequency-domain system analysis using the Laplace transform. Fourier series representation of periodic signals; Fourier transform representation of aperiodic signals. The sampling theorem and the transition from continuous to discrete signals. Students may not receive credit for this and EE 303.

EE 278: Digital Principles

Credits: 3
Pre-requisites: MTH 141 or MTH 153
EE 278
Co-requisites: EE 202 and MTH 306
Approved Electrical Engineering or Computer Engineering Major
Type: LEC

Topics include number systems; arithmetic; codes; Boolean algebra; minimization techniques; logic design; programmable logic devices; memory devices; registers; counters; synchronous sequential networks.

EE 310: Electronic Devices and Circuits I

Credits: 3
Semester(s): Fall
Pre-requisites: EE 202
EE 310
Co-requisites: EE 312 or EE 352
Approved Electrical Engineering, Computer Engineering, or Engineering Physics Major
Type: LEC/REC

Electronic devices, including operational amplifiers, diodes, bipolar junction transistors and field-effect transistors, the basic circuits in which these devices are used, and computer-aided circuit analysis for these devices and circuits.

EE 311: Electronic Devices and Circuits II

Credits: 3
Semester(s): Spring
Type: LEC/LAB

Differential and multistage amplifiers with bipolar junction transistors (BJT) and field-effect transistors (FET). Biasing in integrated circuits and active loads. Frequency response of common-emitter (common-source), common-base (common-gate), common-collector (common-drain) single BJT (FET) stages. Frequency response of differential-pair, cascode, and multistage circuits. Selection of coupling and bypass capacitors. Analog integrated circuits. Metal-Oxide-Semiconductor (MOS) digital circuits with emphasis on CMOS.

EE 312: Basic Electronic Instrumentation Laboratory

Credits: 2
Semester(s): Fall
Pre-requisites: EE 202
EE 312
Co-requisites: EE 310
Approved Computer Engineering Major
Type: LEC/LAB

For computer engineering and other non-EE majors.

Trains students how to design, build, diagnose, and characterize electronic circuits. Topics include instrumentation, semiconductor devices, and electronic circuits. Covers both analog and digital circuits. Laboratory projects include filters, operational amplifiers, dc power supply, MOSFET amplifier, BJT amplifier, logic gates, timing, and counters.

EE 324: Applied Electromagnetics

Credits: 4
Semester(s): Fall, Spring
Pre-requisites: EE 202, MTH 241, PHY 108 or PHY 118;
Approved Electrical Engineering Major
Type: LEC/REC

Topics include vector calculus; electric fields; charge distributions; dielectrics, energy, forces in the presence of dielectrics; Laplace's and Poisson's equations; magnetostatics; Faraday's induction law; time-dependent phenomena; waves.

EE 342: Nanotechnology Engineering and Science Lab

Credits: 3
Type: LAB

The laboratory course consists of ten modules with an experiment in each module. The modules cover basics of modern Nanoelectronics and Nanotechnology. A complete set of laboratory experiments delivers to students a hands-on experience in this field. Students use contemporary equipment to visualize and to characterize nano-world.

EE 352: Introduction to Electronics Lab

Credits: 3
Semester(s): Fall
Pre-requisites: EE 202
Co-requisites: EE 310
Approved Electrical Engineering or Engineering Physics Major
Type: LEC/LAB

Trains students how to design, build, diagnose, and characterize electronic circuits. Topics include instrumentation, semiconductor devices, and electronic circuits. Covers both analog and digital circuits. Laboratory projects include filters, operational amplifiers, diodes, dc power supply, ac power control, BJT amplifier, CMOS, logic gates, timing, and counters.

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EE 353: Electronic Circuits Lab

Credits: 3
Semester(s): Spring
Type: LEC/LAB

An engineering design lab. Fifty-minute lecture and 230-minute lab per week. Involves analyzing and designing single and multistage electronic circuits using FETs, BJTs, and op amps. Asks students to design a variety of amplifiers to meet certain specifications. They practice SPICE and use their knowledge of analog circuits to complete the projects.

EE 383: Communications Systems I

Credits: 3
Pre-requisites: EE 205 or EE 303 and EAS 305; Approved Engineering Major
Type: LEC/LAB

Fourier transforms and spectra; linear filters; transmission of signals through linear systems; bandpass signals; bandpass systems; continuous wave modulation; amplitude modulation (AM); double sideband modulation (DSB); single sideband modulation (SSB), phase modulation (PM); frequency modulation (FM); quadrature amplitude modulation (QAM); frequency division multiplexing (FDM); demodulation of analog modulated signals; random variables; statistical averages; random processes; autocorrelation and power spectral density; stationarity; transmission of random processes through linear systems; white noise; colored noise; Gaussian noise; noise in continuous wave modulation systems; signal-to-noise-ratio (SNR); sampling; pulse amplitude modulation (PAM).

EE 401: Rf and Microwave Circuits I

Credits: 3
Semester(s): Fall
Type: LEC

The first of a two-course sequence in the area of RF and microwave circuit design. Initial topics include transmission line equations, reflection coefficient, VSWR, return loss, and insertion loss. Examples include impedance matching networks using lumped elements, single-section and multi-section quarter wave transformers, single-stub and double-stub tuners, the design of directional couplers, and hybrids. There is a student design project for a planar transmission line circuit based upon the software package Microwave Office. The design is fabricated and tested.

EE 403: Introduction to Plasma Processing

Credits: 3
Semester(s): Spring
Pre-requisites: MTH 242 or MTH 306; PHY 108 or PHY 118; Approved Engineering Major.
Type: LEC

Introduces plasma processing including plasma deposition, plasma etching, gaseous electronics, gas lasers and plasma materials processing. Topics include basic atomic theory, elementary kinetic theory of gases, motion of charges in electric and magnetic fields, plasma properties, plasma generation and devices, plasma-surface interactions, electrodes and discharge characteristics, plasma diagnostics and plasma simulation. Students prepare web-based presentations in current plasma technologies with focus on applications in electrical engineering field.

EE 408: Senior Seminar

Credits: 1
Semester(s): Fall
Type: SEM

Covers the ethical, social, economic, and safety considerations in engineering practice essential for a successful engineering career.

EE 409: Senior Design Implementation

Credits: 2
Pre-requisites: EE 311 And EE 383 And EE 436 And EE 408
Type: SEM

In this senior-level design course, students learn how to take a design from a concept on paper to a finished product, based on knowledge they have obtained in previous electrical engineering courses. Students will work as part of a team in developing their projects, which may be hardware and/or software based projects. Class meetings will deal with fundamentals of engineering design, and students are expected to meet with their team to work on their project outside of class. Students will be expected to present their interim and final results orally and in written form.

EE 410: Electronic Instrument Design I

Credits: 4
Semester(s): Fall
Pre-requisites: EE 310 and Approved Engineering Major
Type: LEC/LAB

Design of electronic instruments, with emphasis on the use of analog and digital integrated circuits. Topics include techniques for precise measurements; sensors and their use for measurement of temperature, displacement, light, and other physical quantities; active and passive signal conditioning; and power supplies. Individuals or groups design and demonstrate an instrument, and provide a written report.

EE 412: Nanophotonics

Credits: 3
Pre-requisites: MTH 306 and PHY 207. Approved Engineering Majors Only.
Type: LEC

Introduces nanophotonics as a field within science and engineering that includes research focused on creating nanoscale structures with desired optical properties, new approaches to manipulating light on a subwavelength scale, as well as using photons to fabricate and characterize nanoscale systems. Topics covered include an introduction to nanophotonics, lithography, growth and synthesis of nanomaterials, structural and optical characterization of nanostructured materials, quantum and optically confined devices, plasmonics, and metamaterials. Applications of nanophotonic devices for bioimaging, sensing, solar energy, and solid-state lighting will also be discussed.

EE 413: Communication Electronics

Electrical Engineering

Credits: 4
Semester(s): Spring
Pre-requisites: EE 352 and EE 353. Approved Engineering Majors Only.
Type: LEC/LAB

Examines operation and signaling in communications systems with a strong emphasis on circuits. Covers radio frequency systems (AM, FM, TV), telephone switching systems, microwave/wireless systems, fiber optics, modulation schemes, coding, multiplexing/demultiplexing, protocols, and networking. Discusses both analog and digital/data communication systems. Requires students to complete a capstone design project.

EE 415: Microelectromechanical Systems

Credits: 3
Semester(s): Fall
Type: LEC

Intended for first-year graduate students. Silicon-based integrated MEMS promise reliable performance, miniaturization and low-cost production of sensors and actuator systems with broad applications in data storage, biomedical systems, inertial navigation, micromanipulation, optical display and microfluid jet systems. The course covers such subjects as materials properties, fabrication techniques, basic structure mechanics, sensing and actuation principles, circuit and system issues, packaging, calibration, and testing.

EE 416: Signal Processing Algorithms

Credits: 3
Semester(s): Spring
Type: LEC/REC

Signals and samples, the z-transform. The discrete Fourier transform. Frequency and time-domain response of filters. Digital filter design, FIR and IIR filters. Digital filter structures. Multi-rate filters and signals. Fast convolution and correlation algorithms. Interdisciplinary aspects: VLSI for DSP; SAW and CCD devices; computational aspects. Heavy design experience with signal processing software. Students are expected to complete several design studies and a final project in the areas of digital filter design and signal processing algorithms. Matlab or similar packages are to be used both in the design process as well as in verification of design objectives.

EE 418: Quantum Mechanics for Engineers

Credits: 3
Pre-requisites: Senior standing; Approved Engineering Major
Type: LEC

Relation to classical mechanics, wave properties, Schrodinger equation, finite barrier potentials, tunneling, perturbation theory, nano-scale devices.

EE 419: Industrial Control Systems

Credits: 3
Semester(s): Fall
Type: LEC/REC

An application-oriented course to introduce students to the basic principles and concepts employed in analysis and synthesis of modern-day analog and microcomputer control systems. Topics include: review of vectors, matrices, and Laplace transforms, followed by introduction to block diagram, signal flow graph, and state-variable representation of physical systems, network and linear graph techniques of system modeling; time-domain, frequency domain, and state-space analysis of linear control systems, control concepts in multivariable systems, hierarchy of control structures, design of analog and digital controllers.

EE 421: Semiconductor Materials

Credits: 3
Semester(s): Fall
Pre-requisites: EE 310; Approved Engineering Major
Type: LEC

Reviews semiconductor materials properties that are important for device operation. Also, discusses semiconductor devices along with important materials properties for each device. Reviews the device models employed in SPICE circuit simulations. Uses several SPICE simulation projects to learn about the SPICE device models and about the effect of materials properties on the device performance and circuit operation. Devices covered are: pn junction diode; SPICE pn junction diode models and model parameters; MOS field effect transistor, SPICE MOSFET models and model parameters; CMOS integrated circuits; bipolar transistor fundamentals; SPICE BJT models and model parameters; MS junction; mesfet; jfet; SPICE models; PSPICE or HSPICE simulations of semiconductor devices.

EE 422: Nanomaterials

Credits: 3
Semester(s): Spring
Pre-requisites: Senior Standing. Approved Engineering Majors Only.
Type: LEC

The recent emergence of fabrication tools and techniques capable of constructing nanometer-sized structures has opened up numerous possibilities for the development of new devices with size domains ranging from 0.1 - 50 nm. The course introduces basic single-charged electronics, including quantum dots and wires, single-electron transistors (SETs), nanoscale tunnel junctions, and so forth. Giant magnetoresistance (GMR) in multilayered structures are presented with their applications in hard disk heads, random access memory (RAM) and sensors. Discusses optical devices including semiconductor lasers incorporating active regions of quantum wells and self assembled formation of quantum-dot-structures for new generation of semiconductor layers. Finally, devices based on single- and multi-walled carbon nanotubes are presented with emphasis on their unique electronic and mechanical properties that are expected to lead to ground breaking industrial nanodevices. The course also includes discussions on such fabrication techniques as laser-ablation, magnetron and ion beam sputter deposition, epitaxy for layer structures, rubber stamping for nanoscale wire-like patterns, and electroplating into nanoscale porous membranes.

EE 423: Nanotechnology & Science

Credits: 3
Pre-requisites: Senior standing
EE 423
Co-requisites: EE 418

Electrical Engineering

Type: LEC

EE 424: Introduction to Nanoelectronics, Nanostructure Physics, and Applications

Credits: 3
Semester(s): Fall
Type: LEC

Covers 2-D electron systems, quantum wires and dots, ballistic transport, quantum interference, and single-electron tunneling.

EE 425: Electrical Devices I

Credits: 1
Semester(s): Spring
Pre-requisites: EE 436 or EE 324
Approved Engineering Major. Students must register for EE425LAB and EE425LEC in the same semester.
Type: LAB

Principles of electromagnetic energy conversion with applications to motors and generators. Topics include magnetic circuits, transformers, hysteresis, field energy, dc and ac motors. Students learn the basic fundamentals of electro-mechanical energy conversion. Design project with laboratory validation accounts for 50 % of grade.

EE 428: Biomems and Lab-on-a-Chip

Credits: 3
Type: LEC

Covers various commonly used micro/nanofabrication techniques, microfluidics, various chemical and biochemical applications such as separation, implantable devices, drug delivery, and microsystems for cellular studies and tissue engineering. Discusses recent and future trends in BioMEMS and nanobiosensors. Students will gain a braod perspective in the area of micro/nano systems for biomedical and chemical applications.

EE 429: Introduction to Electromagnetic Compatibility

Credits: 3
Semester(s): Fall
Type: LEC

EMC deals with interference in electronic systems. For senior and first-year graduate students and industrial professionals who have an interest in designing electronic systems that comply with current commercial and military standards on EMC such as the FCC Part 15 and CISPR 22. Both specify limits on radiated and conducted emissions for digital devices which are defined as any electronic device that has digital circuitry and uses a clock signal in excess of 9 kHz. Student projects designed in electronic instrumentation classes without consideration of the limits imposed by these standards would fail to meet the current standards and as a result could not be marketed in the United States or Europe.

EE 430: Fundamentals of Solid State Devices

Credits: 3
Type: LEC

Develops an understanding of the operation of different semiconductor devices, starting from a quantitative knowledge of semiconductor properties.

EE 435: Java Applet Modeling for Visual Engineering Simulation

Credits: 3
Semester(s): Fall
Type: LEC

Object-oriented analysis, design and programming. Introduces Java syntax, application programmers interface (API), object-oriented programming concepts including encapsulation, inheritance, and polymorphism, and multi-threaded programming including thread synchronization and control. Also introduces graphical programming API and effective graphical programming techniques. Applies all these concepts and techniques to the student-chosen, engineering simulation projects. Emphasizes software engineering processes such as architectural design, unit refinement cycles and code reuse throughout the semester. For the project, requires students to develop a reusable class library consisting of at least three packages: a graphical drawing package, a problem simulation package, and a visual presentation package.

EE 436: Fundamentals of Energy Systems

Credits: 3
Type: LEC

All aspects of electrical energy generation (ac and dc, conventional and alternative), transmission and distribution and utilization with the goal of providing students an idea of how electrical energy affects their life and the world around them. It will provide a firm foundation in phasors, 3 phase circuits, static electromechanical energy conversion, electrical safety, and system level circuit control.

EE 438: Electrochemical Power Sources: Design, Function, and Selection

Credits: 3
Semester(s): Spring
Type: LEC

An introduction to the fundamentals of electrochemistry. Batteries as electromechanical power sources including: battery related terminology, quantitative assessment and comparison methodologies, design considerations for batteries, the chemistry and function of several classes of primary (single use) and secondary (rechargeable) battery types, and appropriate selection of power sources for applications. Students participate in design projects including the development of power systems for specific applications.

EE 441: Special Topics

Credits: 3
Type: LEC

The content of this course is variable and therefore it is repeatable for credit. The University Grade Repeat Policy does not apply.

Topics and instructors vary by semester.

EE 448: Microelectronic Device Fabrication

Credits: 3
Semester(s): Fall
Pre-requisites: EE 311; Approved Engineering Major
Type: LEC

Fabrication technology for microelectronic devices: crystal growth, wafer fabrication and characterization, mask fabrication, epitaxy, lithography, etching, diffusion, CVD, ion implantation, dc and RF plasma reactors (operating principles and fabrication applications), packing. Operation of microelectronic devices (interconnects, passive devices, and MOS and BJT devices), micro-optical devices (CDRs, etc.) and micro electro-mechanical devices (micro-motors, micro-mirror arrays, etc). Students select a part of the fabrication process (lithography, diffusion, etc.) and use simulation code to design that step of the process to achieve specific device properties.

EE 449: Analog Integrated Circuit Layout

Credits: 3
Semester(s): Spring
Type: LEC

Introduces analog integrated circuit fabrication and layout design for analog VLSI. Covers: representative IC fabrication processes (standard bipolar, CMOS and analog BiCMOS); layout principles and methods for MOS transistors and device matching; resistors and capacitors layout; matched layouts of R and C components; bipolar transistors and bipolar matching; and diodes. Also reviews several active-loaded analog amplifier circuits, focusing on CMOS and BiCMOS op amp configuration. Requires a term project on the layout design of simple op amp circuits involving CMOS or BiCMOS op amps plus several matched devices of resistors, capacitors and transistors. Students design circuits using SPICE simulations. The student term project is to be fabricated through MOSIS.

EE 450: Special Topics

Credits: 3
Type: LEC

The content of this course is variable and therefore it is repeatable for credit. The University Grade Repeat Policy does not apply.

Topics and instructors vary by semester.

EE 453: Microelectronic Fabrication Lab

Credits: 3
Type: LEC/LAB

Provides students with the experience of fabricating a semiconductor device. Students become versed in fabrication techniques used in the microelectronics industry. Required student activities include mask design, chemical processing, operation of clean room equipment, and testing of the final device. Also requires a report.

EE 455: Photonic Devices

Credits: 3
Semester(s): Fall
Type: LEC

First, discusses the basics of p-n junctions including current flow, and recombination. In addition, discusses solar cell fundamentals, heterojunctions, metal-insulator-semiconductor devices, design, and recent advances. The course ends with a discussion of photodetector principles, design, and applications.

EE 456: Rf and Microwave Circuits II

Credits: 3
Semester(s): Spring
Type: LEC

The second course of a two-course sequence in the area of RF and microwave circuit design. Topics covered are filters, resonators, detectors, mixers, amplifiers, and microwave systems. Microwave Office is used for CAD analysis of circuits. Students design, construct, fabricate, and measure the performance of a microstrip resonator, a microstrip or stripline directional coupler, and a filter.

EE 458: Rf/Microwave Laboratory

Credits: 3
Semester(s): Fall
Pre-requisites: EE 401 or EE 429 or permission of instructor
Type: LAB/REC

Covers RF & microwave measurement techniques in the 1 MHz to 18 GHz frequency region. Topics include assembling basic measurement systems, including attenuators, directional couplers, power dividers, terminations, power sensors, solid-state detectors, mixers, power meters, and signal generators; measuring the reflection and transmission coefficients at discrete frequencies; making similar measurements (magnitude only) over a band of frequencies using a swept power measurement system consisting of a spectrum analyzer with tracking generator; vector measurements (magnitude and phase) versus frequency using RF & microwave automatic network analyzers.

EE 459: Special Topics in Electrical Engineering

Credits: 3
Semester(s): Fall
Type: LEC/LAB

The content of this course is variable and therefore it is repeatable for credit. The University Grade Repeat Policy does not apply.

Special topics of particular recent interest not covered in the standard curriculum. Requires dual registration in department office.

EE 460: Current Research Topics of Power Modulation Applications

Credits: 3
Semester(s): Fall
Type: LEC

Involves a design project based on electric energy systems that specifically address power modulation applications and that is firmly based on the fundamentals needed to become a successful engineer. Students form Integrated Project Teams (IPTs) to work on the capstone project and answer all the questions that will be required of them when they leave the academic environment. Students are challenged to incorporate engineering standards and realistic constraints that include the economy, environment, sustainability, manufacturability, ethical considerations, health and safety issues, social issues, and politics as stated by ABET. Both technical reports and technical presentations are required of IPT participants.

EE 462: Principles of Medical and Radar Imaging

Credits: 3
Semester(s): Spring
Pre-requisites: EE 303 or EE 205. Approved Engineering Majors Only.
Type: LEC

Applications of multidimensional signal theory and Fourier analysis. Topics include review of signal processing tools and systems used in array imaging, including coherent receivers, pulsed and continuous wave signaling, temporal Doppler phenomenon, and monostatic, quasi-monostatic, bistatic transmitters/receivers, and 2-D signal processing; examining specific array imaging systems, including phased array imaging, synthetic aperture (SAR and ISAR) imaging, passive array imaging, and bistatic array imaging with emphasis on transmission imaging problems of diagnostic medicine and geophysical exploration.

EE 465: Current Research Topics of Pulsed Power Applications

Credits: 1
Semester(s): Spring
Type: LAB

Involves a design project based on pulsed power that utilizes the fundamentals needed to become a successful engineer in the business world. Pulsed power focuses on achieving high peak powers by impulse and rep-rate methods. Topics in this area of research include switching, surface flashover of insulators, and other related areas. Students form Integrated Project Teams to work on their projects and address the relevant issues in a multidisciplinary (electrical engineering) team. Student grades are based on peer reviewed effort, technical reports, and oral presentations.

EE 467: Inegrated Power Electronics

Credits: 3
Type: LEC

Fundamental to electronic systems, i.e. sensors, communications and portable electronics, is the need to deliver electronical power. As today's electronics become smaller, so do the power circuits for conditioning and supplying power. This course introduces inductive and capacitative power switching fundamentals, circuits, and commercial ICs for designing power processing systems. Students will design a power supply including controls. The lectures will introduce patents and descriptions to augment teaching and student understanding.

EE 471: Sustainable Energy Systems

Credits: 3
Pre-requisites: Senior Standing. Approved Engineering Majors Only.
Type: LEC

How can we provide clean, safe, sustainable energy supplies for the U.S. and world as a whole during the twenty-first century, despite rising population levels and increasing affluence? Examines current and potential energy systems, with special emphasis on meeting energy needs in a sustainable manner. Different renewable and conventional energy technologies will be presented and their attributes described within a global energy/environment system. Discusses political, social, and economic considerations on the development of sustainable energy/environment policies.

EE 476: High-Voltage Engineering

Credits: 3
Semester(s): Spring
Type: LEC

Topics include introduction to high-voltage engineering; generation of high voltages (AC, DC, impulse, pulse); measurements of high voltages; destructive and nondestructive insulation test techniques; shielding and grounding; electric shock and safety. Paper in a related high-voltage area and an in-class presentation required.

EE 478: Digital Design

Credits: 3
Semester(s): Spring
Type: LEC

Topics include analysis and design of clocked synchronous sequential networks; design of algorithmic state machines; analysis and design of asynchronous sequential networks; CPLDs and FPGAs; CAD tools; introduction to VHDL.

EE 480: Biomedical Electronics

Credits: 3
Semester(s): Fall
Type: LEC

Covers the principles and designs of various important biomedical instruments including pacemaker, EEG, ECG, EMG, and ICU equipment and diagnostic imaging devices (such as blood bank monitor), CT, MRI, mammography, ultrasound, endoscope, confocal microscope, and multiphoton non-linear microscope (2-photon fluorescent, SHG and THG). Imaging devices (e.g., CCDs) and medical image processing are also covered. Includes a general introduction to biological systems; emphasizes the structural and functional relationship between various biological compartments.

EE 482: Power Systems Engineering I

Credits: 1
Semester(s): Fall
Type: LAB

Surveys the field of modern energy systems, with the foundation being classical electrical power and related power electronics. Topics include complex power, per unit analysis, transmission line parameters and modeling, and compensation. Students also study alternative energy systems in this course. Course also includes use of a Power Simulation Program in which modeling can be done. This program is also used for the final system design project paper which accounts for 50% of the course grade.

EE 484: Communications Systems II

Credits: 3
Semester(s): Spring
Pre-requisites: EE 383 or EE 483 or Senior Standing. Approved Engineering Majors Only.
Type: LEC

Topics include review of PAM-, PDM-, PPM-pulsed modulation techniques; principles of digital communications; pulse code modulation; signal quantization; binary communications systems; M-ary communications systems; detection and parameter estimation for pulses in noise; the likelihood ratio receiver; and applications to radar signal processing.

EE 488: Fundamentals of Modern VLSI Devices

Credits: 3
Semester(s): Fall
Pre-requisites: EE 311
Type: LEC

Device fundamentals of CMOS field effect transistors and BiCMOS bipolar transistors. Device parameters and performance factors important for VLSI devices of deep-submicron dimensions. Reviews silicon materials properties, basic physics of p-n junctions and MOS capacitors, and fundamental principles of MOSFET and bipolar transistors. Design and optimization of MOSFET and bipolar devices for VLSI applications. Discusses interdependency and tradeoffs of device parameters pertaining to circuit performance and manufacturability. Also discusses effects in small-dimension devices: quantization in surface inversion layer in a MOSFET device, heavy-doping effect in the bipolar transistor, etc.

EE 489: Lasers and Photonics

Credits: 4
Semester(s): Fall
Type: LAB

Topics include an introduction to lasers and photonics; a short review of electromagnetic theory; ray tracing and lens systems; polarization of light and polarization modulators; Gaussian beams and wave propagation; optical resonators and cavity stability; spontaneous emission, stimulated emission and absorption; rate equations for gain medium; population inversion; characteristics and applications of specific lasers;waveguides and fiber optics; fiber optic communications systems; electro-optic modulators; and acoustic-optic modulators. Requires students to complete a project focusing on the design of a laser system including choice of gain medium, cavity optics, pumping mechanism, power and efficiency estimates, and cost analysis. Requires reports and presentations.

EE 490: Consumer Optoelectronics

Credits: 4
Semester(s): Spring
Pre-requisites: Senior Standing. Approved Engineering Majors Only.
Type: LEC/LAB

Introduces optoelectronic systems. This design course emphasizes the interaction of optics, lasers, mechanics, electronics, and programming. It requires students design an optoelectronic system with a strong emphasis on team learning and teaching. Some topics of interest include: design methodology; team dynamics; light sources and detectors; light propagation; lens and mirrors; electro optics; interaction of light with materials; nonlinear optics for harmonic generation; optical detection and modulation; and discussion of selected optoelectronic devices and applications such as CD players, DVD, display systems, semiconductor lasers and light emitting diodes, laser printers, barcode scanners, digital cameras, optical coherence tomography, flow cytometry, interferometric systems and optical communications. Requires project proposal, progress reports and presentations and final written reports and presentations.

EE 491: Analog Circuits

Credits: 3
Semester(s): Fall
Pre-requisites: EE 311; Approved Engineering Major
Type: LEC

Focuses on the analysis, design, simulation and mask-level chip layout of integrated analog circuits and systems. Begins with a brief review of MOSFET operation and large and small signal models. Much of the course involves designing and analyzing analog building blocks such as current mirrors, transconductance amplifiers, capacitors, multipliers, current mirrors and D/A and A/D circuits. Simultaneously, the course covers IC design and layout techniques and system analysis. It concludes by looking at sensor applications. Requires a final project consisting of a complete IC layout. Students may have the opportunity to fabricate their final project through MOSIS.

EE 494: Senior Capstone Design Project

Credits: 3
Semester(s): Fall, Spring
Type: SEM

Students design a useful device or product based on knowledge acquired in previous electrical engineering courses. Students have the option of creating their own projects or selecting projects from a list suggested by industrial and faculty sources.

EE 495: Undergraduate Supervised Teaching

Credits: 3
Semester(s): Fall, Spring
Type: TUT

The content of this course is variable and therefore it is repeatable for credit. The University Grade Repeat Policy does not apply.

EE 496: Internship

Credits: 3
Type: TUT

The content of this course is variable and therefore it is repeatable for credit. The University Grade Repeat Policy does not apply.

EE 497: Departmental Honors Thesis or Project

Credits: 3
Type: TUT

The content of this course is variable and therefore it is repeatable for credit. The University Grade Repeat Policy does not apply.

EE 498: Undergraduate Research and Creative Activity

Credits: 3
Type: TUT

Electrical Engineering

The content of this course is variable and therefore it is repeatable for credit. The University Grade Repeat Policy does not apply.

EE 499: Independent Study

Credits: 1-12
Semester(s): Fall, Spring
Type: TUT

The content of this course is variable and therefore it is repeatable for credit. The University Grade Repeat Policy does not apply.

Independent study allows individualized guidance of a faculty member; allows students to study a particular topic that is not offered in the curriculum but is of interest to both the student and faculty member. Requires dual registration in department office.