Electrical Engineering

In the College of Engineering

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The undergraduate degree in Electrical Engineering is accredited by the Engineering Accreditation Commission (EAC) of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: 410-347-7700.

Faculty

Emeritus: Abut, Bailey, Chang, Iosupovici, Harris, J., Lee, L., Lin, Marino, Massey, Panos, Skaar, Stuart, Thyagarajan
Chair: Tummala
The Radio Frequency Communication Systems Industry Chair: Gupta
Professors: Gupta, harris, f., Kolen, Kumar, Lee, G., Ozturk, Szeto, Tummala
Associate Professors: Betancourt, Engin, Nagaraj, Sarkar, Seshagiri, Sharma
Assistant Professors: Alimohammad, Ashrafi

Offered by the Department of Electrical and Computer Engineering

Doctor of Philosophy degree in engineering sciences: (bioengineering), (electrical and computer engineering), (mechanical and aerospace engineering), (structural engineering).
Master of Engineering.
Master of Science degree in electrical engineering.
Major in computer engineering with the B.S. degree.
Major in electrical engineering with the B.S. degree.
Certificate in rehabilitation technology (refer to the *Graduate Bulletin*).

The Radio Frequency Communication Systems Industry Chair

The Radio Frequency (RF) Communications Systems Industry Chair was established in recognition of the pervasiveness and vital role of radio frequency and wireless communications in modern society, and the emergence of San Diego as the world's leading center of research and development in the field of telecommunications and wireless engineering. The chair is sustained through generous contributions of Cubic Corporation and other corporations engaged in wireless communication technology, in appreciation of contributions of students trained in the field at SDSU. The RF Communications Systems Industry Chair is intended to promote excellence in education of RF and microwave engineers, and encourage significant professional activities in the field. Dr. Madhu S. Gupta, the first occupant of the chair, maintains a major involvement in professional work in the discipline and has received international recognition from his professional peers as a distinguished educator and scholar in the field of RF and microwave engineering.

Transfer Credit

No credit will be given for upper division engineering coursework taken at an institution having an engineering program which has not been accredited by the Engineering Accreditation Commission (EAC) of ABET, unless the student successfully completes the first 12 units of engineering work attempted at this university. At that time, and upon recommendation of the department, credit will be given for the unaccredited work.

General Education

Students will complete a minimum of 50 units in General Education, to include a minimum of nine upper division units taken after attaining junior class standing. No more than 12 units may be used for General Education credit from any one department or academic unit. No more than 7 units from one department can be used in Sections II and IV combined (Foundations of Learning and Explorations of Human Experience), nor more than 10 units from one department in Sections II, III, and IV combined (Foundations of Learning, American Institutions, and Explorations of Human Experience).

I. Communication and Critical Thinking: 9 units
You may ***not*** use Credit/No Credit grades in this section.
1. Oral Communication (3 units)
2. Composition (3 units)
3. Intermediate Composition and Critical Thinking (3 units)

II. Foundations of Learning: 29 units

A. Natural Sciences and Quantitative Reasoning (17 units):
1. Physical Sciences (7 units)
Physics 195 (3 units)
Physics 196 and 196L (4 units)
2. Life Sciences (3 units)
Engineering students will take Biology 100 or 101.
3. Laboratory (satisfied under A.1. above)
4. Mathematics/Quantitative Reasoning
You may ***not*** use Credit/No Credit grades.
Mathematics 150 (3 units applicable to General Education)
Mathematics 151 (4 units)

B. Social and Behavioral Sciences (3 units)

C. Humanities (9 units)
Complete three courses in three different areas. One of these courses and the one under IV.A. below must be taken in the same department.

III. American Institutions: Three units of the six units of coursework which meet the American Institutions graduation requirement may be used in General Education, excluding courses numbered 500 and above.

IV. Explorations of Human Experience: Courses in this area must not be taken sooner than the semester in which you achieve upper division standing (60 units passed). Upper division courses in the major department may not be used to satisfy General Education. Total: 9 units; must include one course of cultural diversity.

A. Upper division Humanities (3 units)
Three units must be taken from the same department as one of the Humanities courses selected in Foundations of Learning.

B. Upper division Humanities (3 units from a department not selected in A above.)

C. Upper division Social and Behavioral Sciences (3 units)

After enrollment in electrical engineering at SDSU, an Electrical Engineering major must take all upper division electrical engineering courses at SDSU unless prior approval is obtained from the department.

The Major

The field of Electrical Engineering involves three major activities: the generation and distribution of electric power; the collection, processing and communication of information; and the study and application of electromagnetic phenomena and materials.

The electric power industry is the oldest area of Electrical Engineering, but it remains an active area of innovation and development, as well as a major employer. Activities in the power area include the design of machines for energy conversion (motors and generators); the design of DC power supplies and other electronic circuits for the efficient delivery of electric power from various sources (e.g., solar cells, batteries, AC generators); and the design and operation of systems for the distribution of electric power, including the power grid that cover the United States with links to grids of other countries.

The most dynamic area of Electrical Engineering today is the processing and communication of information. Activities in this area include the design of machines that store, process and display information; and the design of systems for communicating information (e.g., radios, telephones, fax machines, cellular phones, computer networks, the world wide web, satellite communication systems, cable television systems, etc.). Also included in this area are consumer electronics and instrumentation for applications of all sorts (e.g., medical equipment, industrial process control, machine control, bio-engineering, traffic control, radar, sonar, speech analysis and synthesis, music, etc.).

The study of electromagnetic phenomena and materials provides the foundation for all of Electrical Engineering. Research and development at this level typically leads to new developments and improvements in other areas. Major activities today include the study of energy conversion processes, fabrication processes, imaging techniques, information storage mechanisms, environmental processes, and optoelectronics (e.g., lasers, optical fibers, optical computing).

The Bachelor of Science degree program includes a core of courses that provides an introduction to each of the major areas described above. In addition, nearly a full year of professional electives provides the opportunity for students to specialize in areas of particular interest. The process of engineering design is emphasized throughout the curriculum by including open-ended problems with realistic design constraints. The design experience culminates in a capstone design course required of all students. Creativity, consideration of economic and social factors, and the application of systematic design procedures are used to solve problems that confront engineers. The curriculum attempts to achieve a balance between theory and practice that will prepare graduates both for immediate employment and for continued study. The Master of Science program offers graduates in electrical engineering and related fields the opportunity for continued study and further specialization.

Employment opportunities within the electrical engineering profession are challenging and usually plentiful. Electrical engineering graduates are sought by a wide range of employers in government and industry for many different types of work including design, testing, production, maintenance, system operation, programming, customer support engineering, and technical marketing and sales. Graduates have the opportunity to contribute to society by helping to design and supply the high-quality products and services that are necessary for a robust economy.

Educational Objectives

The overall objective of the undergraduate program in electrical engineering is to produce the best skilled, hands on practicing electrical engineer. More specifically the objectives are:

A. To provide students with the technical knowledge and skills that will enable them to have a successful career in the electrical engineering profession;

B. To provide students with a general education that will enable them to appreciate the social, ethical, economic, and environmental dimensions of problems they may face;

C. To develop in students the communication skills and social skills that are necessary to work effectively with others;

D. To develop the ability of students to solve problems by learning what is already known, and then applying logic and creativity to find a solution;

E. To provide students with the intellectual skills necessary to continue learning and to stay current with the profession as it changes.

Impacted Program

The electrical engineering major is an impacted program. To be admitted to the electrical engineering major, students must meet the following criteria:

a. Complete with a grade of C or higher: Electrical Engineering 210; Computer Engineering 160; Mathematics 150, 151; Physics 195, 196. These courses cannot be taken for credit/no credit (Cr/NC);

b. Have an overall cumulative GPA of 2.1.

To complete the major, students must fulfill the degree requirements for the major described in the catalog in effect at the time they are accepted into the premajor at SDSU (assuming continuous enrollment).

Major Academic Plans (MAPs)

Visit http://www.sdsu.edu/mymap for the recommended courses needed to fulfill your major requirements. The MAPs website was created to help students navigate the course requirements for their majors and to identify which General Education course will also fulfill a major preparation course requirement.

Electrical Engineering Major

With the B.S. Degree

(Major Code: 09091) (SIMS Code: 443001)

The program below describes the 130 units required for the degree. Each course specifically listed in the program is required. In addition, the total number of units specified in each elective category represents a minimum requirement. These are General Education, American Institutions, Upper Division Engineering Elective, Professional Electives, and Electrical Engineering Laboratory Electives.

Preparation for the Major. Electrical Engineering 210; Aerospace Engineering 280; Biology 100 or 101; Computer Engineering 160, 270, 271; Mathematics 150, 151, 252, 254; Physics 195, 195L, 196, 196L. (41 units)

Electrical Engineering 210; Computer Engineering 160; Mathematics 150, 151; Physics 195, 196 must be completed with a grade of C or higher. These courses cannot be taken for credit/no credit (Cr/NC).

General Education. Engineering students must follow the specific General Education program outlined in this section of the catalog. Other general education requirements and limitations, as well as listings of specific General Education course electives are presented in the General Education section of Graduation Requirements for the Bachelor's Degree. (Fifty units, including 17 units from preparation for the major which count toward General Education credit, and 3 units of American institutions which count toward General Education credit.)

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 53 upper division units to include the following required and professional elective courses. Required upper division courses in the major: Electrical Engineering 300, 310, 330, 330L, 340, 380, 410, 420, 430, 434, 440, 490; Computer Engineering 375. Professional electives: Twelve units selected from upper division electrical engineering courses and no more than three units from approved upper division courses from other departments. Electrical Engineering laboratory electives: Three units selected from any non-required upper division electrical engineering laboratory courses.

Master Plan. A master plan of elective courses must be approved by the faculty adviser and department chair and filed with the Office of Advising and Evaluations during the first semester of the junior year. Changes to the master plan are permitted at any time, with approval of the department chair. After enrollment in electrical engineering at SDSU, an electrical engineering major must take upper division electrical engineering courses at SDSU unless prior approval is obtained from the department.

Courses (E E)

Refer to Courses and Curricula and University Policies sections of this catalog for explanation of the course numbering system, unit or credit hour, prerequisites, and related information.

NOTE: Prerequisites will be enforced in all undergraduate electrical engineering courses numbered 100 through 596. A copy of an official transcript will be accepted as proof. For corequisites, an enrollment confirmation form will be accepted.

LOWER DIVISION COURSES

E E 204. Principles of Electrical Engineering (3)
Prerequisites: Mathematics 151 and Physics 196.
Circuit analysis, phasor diagrams, single-phase and three-phase power, semiconductor devices and applications, and energy conversion devices. Not acceptable for electrical or computer engineering majors.

E E 210. Circuit Analysis I (3)
Prerequisites: Mathematics 151 and Physics 196.
Circuit analysis by reduction methods, Thevinin and Norton's equivalence, mesh current and nodal voltage analysis. Transient analysis of first-order circuits and use of phasors for steady-state sinusoidal analysis. Operational amplifier models, impedance, power. Computer software tools for circuit analysis.

UPPER DIVISION COURSES (Intended for Undergraduates)

E E 300. Computational and Statistical Methods for Electrical Engineers (3)
Prerequisite: Electrical Engineering 210.
Random signals and events in electrical engineering. Introduction to basic probability, discrete and continuous random variables, joint random variables. Application of probabilistic models and concepts to engineering; data analysis and point estimation using computer-aided engineering tools.

E E 310. Circuit Analysis II (3)
Prerequisites: Grade of C (2.0) or better in Electrical Engineering 210. Grade of C- (1.7) or better in Mathematics 252 or both Aerospace Engineering 280 and Mathematics 254.
Transient and frequency response of RLC circuits. Mutual inductance, network analysis using Laplace transformations, network functions, stability, convolution integrals, Bode diagrams, two-port networks, computer analysis of circuits.

E E 330. Fundamentals of Engineering Electronics (3)
Prerequisite: Electrical Engineering 210.
Application of diodes JFETs, MOSFETs, and BJTs in typical electronic circuits. Analysis and design of rectifiers, filters, and simple amplifiers using transistors and operational amplifiers.

E E 330L. Engineering Electronics Laboratory (1)
Three hours of laboratory.
Prerequisite: Credit or concurrent registration in Electrical Engineering 330.
Experimental study of laboratory instruments, diodes, rectifier circuits, filters, transistors, and operational amplifiers.

E E 340. Electric and Magnetic Fields (3)
Prerequisites: Grade of C (2.0) or better in Electrical Engineering 210. Grade of C- (1.7) or better in Aerospace Engineering 280.
Electrostatic and magnetostatic field theory using vector notation; Coulomb's Law, Gauss' Law and potential theory. Solutions to Poisson's and Laplace's equations; capacitance and inductance. Time-varying fields; Maxwell's equations.

E E 380. Electrical Energy Conversion (3)
Prerequisite: Electrical Engineering 210.
Magnetic circuits, transformers and polyphase AC networks. Fundamentals of electro-mechanical energy conversion; induction motors, synchronous machines and DC machines.

E E 380L. Electrical Energy Conversion Laboratory (1)
Three hours of laboratory.
Prerequisite: Credit or concurrent registration in Electrical Engineering 380.
Experimental study of DC, single and polyphase AC circuits, transformers, and machines.

E E 397. Discussion: Electrical Engineering (1) Cr/NC
Prerequisite: Concurrent registration in associated course.
Discussion and examples of problem-solving techniques in subject area. Weekly writing assignments summarizing material covered in lecture and identifying troublesome topics. Not applicable to a bachelor's degree.

E E 410. Signals and Systems (3)
Prerequisites: Electrical Engineering 300 and 310. File an approved master plan with the Department of Electrical and Computer Engineering.
Linear time-invariant systems, Fourier analysis, continuous and discrete signals and systems, sampling and Laplace transform techniques.

E E 420. Feedback Control Systems (3)
Prerequisite: Electrical Engineering 410.
Control systems including servomechanisms by Laplace transform method. System performance and stability; Nyquist, Bode, and root-locus diagrams; elementary synthesis techniques. Practical components and examples of typical designs.

E E 430. Analysis and Design of Electronic Circuits (3)
Prerequisites: Electrical Engineering 310, 330, and Aerospace Engineering 280.
Single and multiple transistor amplifiers, power stages. Frequency response, feedback, stability, and operational amplifier circuits.

E E 430L. Electronic Circuits Laboratory (1)
Three hours of laboratory.
Prerequisites: Electrical Engineering 330L and 430.
Transistor dynamic characteristics; single stage and multistage amplifier circuits including feedback, tuned amplifiers, voltage regulators, active filters, and A/D-D/A converters.

E E 434. Electronic Materials and Devices (3)
Prerequisites: Electrical Engineering 330 and 340.
Crystal properties and growth of semiconductors, quantum mechanics of solids, shot noise and thermal noise, energy band and charge carriers, excess carrier in semiconductors, p-n junctions, solar cells, tunnel diodes, photodetectors.

E E 439. Instrumentation Circuits (3)
Prerequisite: Electrical Engineering 430.
Design and analysis of mixed signal, analog/digital, electronic systems. Emphasis on operational amplifier based circuit design with design procedures needed to accommodate amplifier limitations in real world applications. Introduction to digitally controlled, analog signal processing.

E E 440. Electromagnetic Waves (3)
Prerequisites: Electrical Engineering 310 and 340.
Time-domain form of Maxwell equations, electromagnetic wave propagation in unbound media, Poynting vector, reflection of plane waves, transmission line theory, Smith chart, different microwave transmission lines, wave propagation in bounded media, waveguides, and introduction to antennas.

E E 455. Antenna Theory and Design (3)
Prerequisite: Electrical Engineering 440.
Wireless communication system. Fundamental antenna parameters, theory and design of different types of antennas (wire, aperture, broadband, array), and techniques for antenna analysis, fabrication and measurement.

E E 458. Analog and Pulse Communication Systems (3)
Prerequisite: Electrical Engineering 410.
Analog and digital communication systems. Amplitude and frequency modulation, pulse modulation, and PCM. Introduction to information theory.

E E 458L. Communications and Digital Signal Processing Laboratory (1)
Three hours of laboratory.
Prerequisite: Credit or concurrent registration in Electrical Engineering 458.
Experiments in modulation techniques, effects of noise on system performance, digital filters, and signal processing. (Formerly numbered Electrical Engineering 558L)

E E 480. Power System Analysis (3)
Prerequisites: Aerospace Engineering 280, Electrical Engineering 310 and 380.
Modern power system elements; calculation of load flow, fault currents, and system stability.

E E 483. Power Distribution Systems (3)
Prerequisite: Electrical Engineering 380.
Design and operation of electric power distribution systems. Design of primary and secondary systems, application of one phase and three phase transformer banks, and metering principles and practices.

E E 484. Power Electronics (3)
Prerequisites: Electrical Engineering 380 and credit or concurrent registration in Electrical Engineering 430.
Design and analysis of power electronic devices. Power semiconductor switches, switch-mode power supplies, dc-to-ac inverters, PM and PWM ac-to-ac converters. Power electronics applications. (Formerly numbered Electrical Engineering 583.)

E E 490. Senior Design Project (4)
Two lectures and six hours of laboratory.
Prerequisites: Computer Engineering 375, Electrical Engineering 330L, 410, and 430.
Supervised capstone design projects to provide integrative design experience for seniors to include ethics, professionalism, cost-effectiveness, and project management.

E E 496. Advanced Electrical Engineering Topics (1-3)
Prerequisite: Consent of instructor.
Modern developments in electrical engineering. See *Class Schedule* for specific content. Maximum credit nine units for any combination of Electrical Engineering 496 and 596 applicable to a bachelor's degree.

E E 499. Special Study (1-3)
Prerequisites: Approval of project adviser and department chair.
Individual study. Maximum credit six units.

UPPER DIVISION COURSES
(Also Acceptable for Advanced Degrees)

E E 502. Electronic Devices for Rehabilitation (3)
Two lectures and three hours of laboratory.
Prerequisite: Electrical Engineering 330.
Recent developments in electronic assistive devices and microcomputers for persons with various disabilities; assessment of disabled persons for suitable technological assistive devices.

E E 503. Biomedical Instrumentation (3)
Prerequisites: Aerospace Engineering 280; Electrical Engineering 410 and 430 (or for Mechanical Engineering majors, Electrical Engineering 204 and Mechanical Engineering 330).
Instrumentation systems to monitor, image, control, and record physiological functions.

E E 530. Analog Integrated Circuit Design (3)
Prerequisite: Electrical Engineering 430 with minimum grade of C-.
Advanced treatment of transistor pairs, device mismatches, differential amplifiers, current mirrors, active loads, level shifting, and output stages. Parasitic and distributed device parameters. Economics of IC fabrication and impact on design.

E E 534. Solid-State Devices (3)
Prerequisite: Electrical Engineering 434.
Conduction theory of solids. Characteristics of tunnel, backward, breakdown, multilayer and varactor diodes; silicon controlled rectifiers and switches, unijunction transistors, hot electron devices. Lasers and laser applications.

E E 540. Microwave Devices and Systems (3)
Prerequisite: Electrical Engineering 440. Recommended: Aerospace Engineering 515.
Applications of Maxwell's equations to wave propagation. Microwave network parameters; guided wave transmission and reflection. Design of filters, couplers, power dividers and amplifiers. Applications in radar and telecommunications systems.

E E 540L. Microwave Design and Measurements Laboratory (1)
Three hours of laboratory.
Prerequisites: Credit or concurrent registration in Electrical Engineering 430L and 540.
Designs, computer simulations, fabrications, and testings of microwave matching networks, couplers, filters, and amplifiers.

E E 541. Electro-Optics (3)
Prerequisite: Electrical Engineering 434.
Optical/electronic devices and systems; wave beams; light-matter quantum interactions; incoherent and laser light sources; modulators and detectors. Applications in data transmission, measurement, and materials processing.

E E 556. Digital Signal Processing (3)
Prerequisite: Electrical Engineering 410.
Discrete-time signals and systems, Sampling, Z-transform, Discrete-time Fourier transform and frequency responses, DFT, FFT, and introduction to IIR and FIR digital filter design.

E E 558. Digital Communications (3)
Prerequisite: Electrical Engineering 458.
Design of baseband digital communication systems; noise characterization, sampling, quantization, matched filter receivers, bit-error performance, inter-symbol interference, link budget analysis.

E E 581. Power System Dynamics (3)
Prerequisite: Electrical Engineering 480.
Three-phase faults, symmetrical components, unsymmetrical faults, protective relay operating principles, economic dispatch of thermal power generation units, power system controls, voltage and power stability.

E E 596. Advanced Electrical Engineering Topics (1-3)
Prerequisite: Consent of instructor.
Modern developments in electrical engineering. May be repeated with new content. See *Class Schedule* for specific content. Maximum credit of nine units for any combination of Electrical Engineering 496 and 596 applicable to a bachelor's degree. Maximum combined credit of six units of Electrical Engineering 596 and 696 applicable to a 30-unit master's degree. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

GRADUATE COURSES
Refer to the *Graduate Bulletin*.