Electrical Engineering

In the College of Engineering

OFFICE: Engineering 426
TELEPHONE: (619) 594-5718
EMAIL: ee@engineering.sdsu.edu

The undergraduate degree in Electrical Engineering is accredited by the Accreditation Board for Engineering and Technology, Inc.

Faculty

Emeritus: Abut, Bailey, Brown, Chan, Iosupovici, Lin, Lodge, Mann, Massey, Panos, Skaar, Stuart, Thyagarajan, Wilson
Chair: Tummala
Professors: Chang, Gupta, harris, f., Harris, J., Kolen, Lee, G., Lee, L., Marino, Szeto, Tummala
Associate Professors: Betancourt, Ozturk
Assistant Professors: McPheters, Park, Rasmussen, Singh

Offered by the Department of Electrical and Computer Engineering

Doctor of Philosophy degree in engineering sciences/applied mechanics.
Master of Science degree in electrical engineering.
Major in electrical engineering with the B.S. degree.
Certificate in rehabilitation technology (refer to *Bulletin of the Graduate Division*).

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 Accreditation Board for Engineering and Technology, Inc., 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 twelve 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, III, and IV combined (Foundations, American Institutions, and Explorations).

I. Communication and Critical Thinking: 9 units

1. Oral Communication (3 units)
2. Composition (3 units)
3. Intermediate Composition and Critical Thinking (3 units)

II. Foundations: 29 units

A. Natural Sciences and Quantitative Reasoning (17 units):
1. Physical Sciences (11 units)
Engineering students will take Chemistry 200 which includes a laboratory (5 units).
Physics 195 (3 units)
Physics 196 (3 units)
2. Life Sciences (3 units)
3. Laboratory (satisfied under A.1. above)
4. Mathematics/Quantitative Reasoning
Engineering students will take Mathematics 150, 3 units applicable to General Education.

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: 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.

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 objectives of the undergraduate program in electrical engineering are:

A. To provide students with an education that will enable them to have a successful career in the electrical engineering profession;

B. To provide students with a significant exposure to the humanities and social sciences in order to give them an understanding of the impact of electrical engineering solutions in a global, societal, and environmental context; and

C. To inspire in students an open but critical approach to the analysis of problems, considering the technical, social, economic, and ethical dimensions of any solution.

Electrical Engineering Major

With the B.S. Degree (Major Code: 09091)

The program below describes the 131 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, Electrical Engineering Laboratory Electives, and the Electrical Engineering Capstone Elective.

Preparation for the Major. Electrical Engineering 210; Chemistry 200; Computer Engineering 160, 270, 271; Engineering 280; Engineering Mechanics 202; Mathematics 150, 151, and 252; Physics 195, 196, 196L. (43 units, 14 units of which count toward General Education credit.)

General Education. Engineering students must follow the specific General Education program outlined on the previous page. Other General Education requirements and limitations, as well as listings of specific General Education course electives are presented in Section IX of Graduation Requirements for the Bachelor's Degree. (Fifty units, including 14 units from preparation for the major which count toward General Education credit, and 3 units of American institutions which count toward General Education credit.)

FRESHMAN YEAR

Fall Semester	*Units*	*Spring Semester*	*Units*
Chemistry 200, General Chemistry	5	COMPE 160, Intro. to Computer Prog.	3
Mathematics 150, Calculus I	5	Mathematics 151, Calculus II	4
General Education	6	Physics 195, Principles of Physics	3
		General Education	6
	16		16

SOPHOMORE YEAR

Fall Semester	*Units*	*Spring Semester*	*Units*
EM 202, Mechanics for Elec. Engrs	3	EE 210, Circuit Analysis I	3
COMPE 270, Digital Systems	3	COMPE 271, Computer Organization	3
Mathematics 252, Calculus III	4	Engineering 280, Methods of Analysis	3
Physics 196, 196L, Principles of Physics	4	General Education	6
General Education	3		
	17		15

JUNIOR YEAR

Fall Semester	*Units*	*Spring Semester*	*Units*
EE 300, Comp. and Stat. Methods	3	EE 340, Elec. and Magnetic Fields	3
EE 310, Circuit Analysis II	3	EE 380, Elec. Energy Conversion	3
EE 330, 330L, Fund. Engr. Electronics	4	EE 410, Signals and Systems	3
Upper Division Engr. Elective	3	EE 430, Analysis and Design of Electronic Circuits	3
General Education	3	General Education	6
	16		18

SENIOR YEAR

Fall Semester	*Units*	*Spring Semester*	*Units*
EE Laboratory Elective	1	EE Laboratory Electives	2
EE 434, Elec. Matls. and Devices	3	Professional Electives	12
Professional Electives	6	American Institutions	3
American Institutions	3		
General Education	3		
	16		17

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.

Upper Division Writing Requirement. Each student must pass the University Writing Examination or complete one of the approved writing courses with a grade of C (2.0) or better.

Major. A minimum of 49 upper division units to include the following required and elective courses. Required upper division courses in the major: Electrical Engineering 300, 310, 330, 330L, 340, 380, 410, 430, and 434. General engineering electives: Three units selected from Civil Engineering 301 or Engineering Mechanics 340 or Mechanical Engineering 260 or Mechanical Engineering 352. Professional electives: Fifteen units selected from any upper division electrical engineering and at most three units (out of these 15 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. Electrical Engineering capstone design elective: Three units selected from a list of design courses approved by the department.

Elective courses are subject to the approval of the faculty adviser and the department chair. The student must file an approved Master Plan during the first semester of the junior year specifying the electives selected. Changes to the Master Plan are permitted at any time upon approval by 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)

NOTE: Prerequisites will be enforced in all undergraduate electrical engineering courses numbered 100 through 599. A copy of an official transcript will be accepted as proof. For corequisites, an enrollment confirmation form will be accepted.

Any course at the 300 level or below must be passed with a grade of C- or better in order to be used as a prerequisite for any subsequent course.

LOWER DIVISION COURSES

203. Principles of Electrical Engineering (3) I, II

Prerequisites: Mathematics 151 and Physics 196.

Direct and alternating current analysis, phasor diagrams, single-phase and three-phase power, diodes, transistors, integrated circuits, transformers, motors, and generators. Not acceptable for electrical, aerospace, or civil engineering majors.

204. Principles of Electrical Engineering (3) I, II

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 mechanical engineering majors.

210. Circuit Analysis I (3) I, II (CAN ENGR 12)

Prerequisites: Mathematics 151 and Physics 196.

Circuit analysis by reduction methods, source transformations, mesh and nodal analysis. Operational amplifier model, transient analysis, alternating current circuits, impedance, power, phasor diagrams, and three-phase balanced networks. Computer programming and application of computer software for circuit analysis.

UPPER DIVISION COURSES (Intended for Undergraduates)

300. Computational and Statistical Methods for Electrical Engineers (3) I, II

Prerequisites: Computer Engineering 160 and Mathematics 151.

Deterministic and statistical concepts and models in electrical engineering. Associated plotting and numerical techniques. Graphical representation of data and signal processing using computer-aided engineering tools.

303. Electronics, Instrumentation, and Electrical Energy Conversion (3) I, II

Prerequisite: Electrical Engineering 203 with minimum grade of C.

Theory and application of diodes and transistors in typical electronic circuits. Instrumentation and electronic measuring devices. Fundamentals of electro-mechanical energy conversion including motors and transformers. Not open to electrical engineering majors.

310. Circuit Analysis II (3) I, II

Prerequisites: Electrical Engineering 210 and either Mathematics 252 or both Engineering 280 and Mathematics 254.

Transient and frequency response of RLC circuits. Mutual inductance generalized network analysis using Laplace transformations, network functions, poles and zeros, stability of circuits, convolution integrals, Bode diagrams, two-part networks, computer-aided analysis of circuits.

330. Fundamentals of Engineering Electronics (3) I, II

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.

330L. Engineering Electronics Laboratory (1) I, II

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.

340. Electric and Magnetic Fields (3) I, II

Prerequisites: Electrical Engineering 210 and 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.

380. Electrical Energy Conversion (3) I, II

Prerequisite: Electrical Engineering 210.

Magnetic circuits, transformers and polyphase AC networks. Fundamentals of electro-mechanical energy conversion; induction motors, synchronous machines and DC machines.

380L. Electrical Energy Conversion Laboratory (1) I, II

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.

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.

410. Signals and Systems (3) I, II

Prerequisites: Electrical Engineering 300 and 310.

Linear time-invariant systems, Fourier analysis, continuous and discrete signals and systems, filtering, sampling, and Z-transform techniques.

430. Analysis and Design of Electronic Circuits (3) I, II

Prerequisites: Electrical Engineering 310, 330, and Engineering 280.

Single and multiple transistor amplifiers, power stages. Frequency response, feedback, stability, and operational amplifier circuits.

430L. Electronic Circuits Laboratory (1) I, II

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.

434. Electronic Materials and Devices (3) I, II
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.

440L. Physical Electronics Laboratory (1)
Prerequisites: Electrical Engineering 330 and 340.
Experimental study of electrical properties of semiconductors, light transmission in optical fibers, transmission and reflection of electromagnetic waves, laser oscillation and amplification, and gaseous electrical discharge.

450. Transmission Lines for High Speed Electronics and Microwaves (3)
Prerequisites: Electrical Engineering 330 and 340.
Theory and applications of transmission lines. Transmission-line equations and four transmission-line parameters, pulses on transmission lines, and impedance matching techniques, scattering matrix, microstrip line, coplanar waveguides, and various microwave transmission line components.

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

483. Power Distribution Systems (3) II
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.

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.

499. Special Study (1-3) I, II
Prerequisite: Approval of project adviser and department chair.
Individual study. Maximum credit six units.

UPPER DIVISION COURSES
(Also Acceptable for Advanced Degrees)

502. Electronic Devices for Rehabilitation (3)
Two lectures and three hours of laboratory.
Prerequisite: Electrical Engineering 303 or 330.
Recent developments in electronic assistive devices and microcomputers for persons with various disabilities; assessment of disabled persons for suitable technological assistive devices.

503. Biomedical Instrumentation (3)
Prerequisites: Engineering 280; Electrical Engineering 410 and 430 (or for Mechanical Engineering majors, Electrical Engineering 303 and Mechanical Engineering 512).
Instrumentation systems to monitor, image, control, and record physiological functions. (Formerly numbered Electrical Engineering 403.)

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

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.

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.

539. Instrumentation Circuits I (3)
Prerequisite: Electrical Engineering 430.
Design and analysis of hybrid analog/digital electronic sub-systems incorporated into modern instrument design. Emphasis on operational amplifier based circuit design and analog-to-digital and digital-to-analog conversion processes.

540. Microwave Devices and Systems (3)
Prerequisite: Electrical Engineering 340. Recommended: Engineering 510.
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.

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.

541. Electro-Optics (3) II
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.

546. Optical Fiber Communications Systems (3)
Prerequisite: Electrical Engineering 434.
Optical fiber attenuation and dispersion, light-emitting diodes and laser diodes, PIN diodes and avalanche photodiodes, receiver designs, optical power budgets and rise time budgets, applications in digital and analog communication systems.

553. Stochastic Signals (3) I
Prerequisite: Electrical Engineering 410.
Random signals, correlation functions, power spectral densities, the Gaussian process, narrow band processes. Applications to communication systems.

556. Digital Signal Processing (3)
Prerequisite: Electrical Engineering 410 or Physics 516.
Digital signal processing. Discrete-time signals, transform techniques, and digital filters. Design of FIR and IIR filters, FFTs, and finite length effects on digital systems.

558. Communication Systems II (3) II
Prerequisite: Electrical Engineering 458.
Performance of analog and digital communication systems. Effects of noise and spectral characteristics.

558L. Communications and Digital Signal Processing Laboratory (1)
Prerequisite: Electrical Engineering 558.
Experiments in modulation techniques, effects of noise on system performance, digital filters, and signal processing.

570. Advanced Digital Circuits (3)
Prerequisite: Computer Engineering 470.
Digital applications of linear devices, the digital/analog interface, and ultra high speed logic devices.

580. Modern Power Systems I (3) I
Prerequisites: Engineering 280, Electrical Engineering 310 and 380.
Modern power system elements; calculation of load flow, fault currents, and system stability.

581. Modern Power Systems II (3) II
Prerequisite: Electrical Engineering 580.
Transient response of modern power system elements; positive, negative and zero sequence impedance; subharmonic effects.

582. Power Relay Systems (3) I
Prerequisite: Electrical Engineering 380.
Power relays including metering and control as used in modern power systems. Characteristics of operations and applications of equipment. Demonstrations on individual component relays. Basic relay calculations.

583. Power Electronics (3)
Prerequisites: Electrical Engineering 380 and 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.

596. Advanced Electrical Engineering Topics (1-3) I, II
Prerequisite: Consent of instructor.
Modern developments in electrical engineering. 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 credit of six units of Electrical Engineering 596 applicable to a 30-unit master's degree.

GRADUATE COURSES
Refer to the Bulletin of the Graduate Division.