Electrical Engineering is a diverse discipline encompassing computer and information systems, controls, lasers, robotics, photonics, signal processing, artificial intelligence, telecommunications, solid state and integrated electronics, and more. It is a part of every industry, from environmental engineering and manufacturing to semiconductors and telecommunications.

The Electrical Engineering curriculum provides a diverse background in physics, materials and mathematics, balancing fundamental core courses with the newest developments in engineering technology. During their freshman year, students are introduced to the concepts of digital logic, the fundamentals of computer programming, and core courses in math and physics. Beginning in their junior year, students can choose courses that will emphasize areas such as computers, communications and signal processing, robotics, electromagnetics, or circuits and devices. In addition, they will take design courses to prepare them to address the specific needs of a number of industries.

USC’s EE Department operates a number of nationally known research centers, including the Center for Photonics Technology and the Signal and Image Processing institute.

Programs Available

- Electrical Engineering Bachelor of Science 131 units
- Computer Engineering and Computer Science Bachelor of Science (see page 60) 132 units
- Electrical Engineering (Computers) degree emphasis
- Electrical Engineering (Integrated Media Systems) degree emphasis
- Electrical Engineering combined Bachelor’s and Master’s
- Interactive Multimedia minor
- Multimedia & Creative Tech. minor
- Music Recording minor (through the Music School)

See page 68 for the curriculum of the BSEE program listed above. Information on each degree emphasis can be found below.

See pages 78-79 for information on minor programs offered by the School of Engineering.

Emphasis in Computers

The Bachelor of Science in Electrical Engineering (Computers) is earned by successfully completing the normal requirements for the Bachelor of Science in Electrical Engineering with the following courses chosen as EE electives: EE 454L, CSCI/EE 455x, EE 457x, and EE 478L.

Emphasis in Integrated Media Systems

This 134-unit program will expose students to the creative technology side of multimedia. To obtain this degree, the student must successfully complete the normal requirements for the Bachelor of Science in electrical engineering with the following restrictions: (1) students must take the following entry-level electives in the topical area of Communication, Control and Signal Processing: EE 241 (3) and EE 483 (3) (which replaces the requirement to take EE 301b); and (2) the student must take the following courses chosen as EE electives: CSCI 351, CSCI 480, EE 434L, EE 450 and EE 469.

Industry recommends that students also be exposed to the creative-artistic side of multimedia. This can be accomplished by students taking the Minor in Multimedia and Creative Technologies (described on page 79). Because all of the technical requirements and electives for that minor will have been taken as a part of the BSEE (IMS), students can complete the minor by focusing on the minors creative-artistic requirements. Up to 6 units from the BSEE (IMS) can be counted toward the minor.

Combined Bachelor’s and Master’s Program in Electrical Engineering

Students who have demonstrated exceptional academic success have the opportunity to earn both Bachelor’s and master’s degrees in an accelerated 5-year degree program. See the Engineering Student Affairs Office for details.

Minor in Interactive Multimedia

See page 78 for information on the Minor in Interactive Multimedia. Note that this minor is not open to students in the School of Engineering (these students should pursue the Multimedia and Creative Technologies Minor instead).

Minor in Multimedia and Creative Technologies

See page 79 for information on the Minor in Multimedia and Creative Technologies.

Minor in Music Recording

See the USC Thornton School of Music section of the USC Catalogue for information on the Minor in Music Recording.

Electrical Engineering Electives, Topics and Areas of Specialization

All students pursuing the Electrical Engineering B.S. degree must complete at least 43 units of engineering electives as outlined below. Engineering electives are to be chosen from the courses listed under entry-level electives, areas of specialization, non-EE engineering science elective and EE design electives. See page 68 to determine where these courses fit into the curriculum.
Students must complete all the courses listed under three of the four following topical areas:

1. Comm., Control & Signal Processing
   - EE 241 (3)
   - EE 301b (3)
2. Computer Engineering
   - EE 102L (2)
   - EE 357 (3)
3. Electromagnetics and Energy Conv.
   - EE 370 (3)
   - EE 470 (3)
4. Electronic Devices and Circuits
   - EE 338 (3)
   - EE 348L (4)

Specialization Electives (9-12 units)
In addition to the Entry-Level Electives above, choose at least one of the 13 areas of specialization listed below and complete its courses as noted:

Communication, Control & Signal Processing
1. Control Systems (take all 3):
   - EE 401 (3)
   - EE 454L (4)
   - EE 482 (3)
2. Systems (take 3 of 4):
   - EE 434L (4)
   - EE 467x (3)
   - EE 482 (3)
   - EE 483 (3)
3. Digital Signal Processing (take all 3):
   - EE 469 (3)
   - EE 434L (4)
   - EE 483 (3)
4. Communication Networks (take 3 of 4):
   - CSCI 402x (3)
   - EE 450 (3)
   - EE/CSCI 455x (4)
   - EE 467x (3)
   - EE 401 (3)
   - EE 447L (4)
   - EE 450 (3)
   - EE 467x (3)
6. Robotics (take all 3):
   - CSCI 445 (3)
   - EE 454L (4)
   - EE 482 (3)

Computer Engineering
7. Comp. Arch. and Org. (take all 3):
   - EE 454L (4)
   - EE 457x (3)
   - EE 459L (3)
8. Hardware/Software (take 3 of 4):
   - CSCI 402x (3)
   - EE 454L (4)

Electrical Engineering (EE)

1. Comm., Control & Signal Processing
   - EE 241 (3)
   - EE 301b (3)
2. Computer Engineering
   - EE 102L (2)
   - EE 357 (3)
3. Electromagnetics and Energy Conv.
   - EE 370 (3)
   - EE 470 (3)
4. Electronic Devices and Circuits
   - EE 338 (3)
   - EE 348L (4)

Electronic Devices and Circuits
12. Electronic Circuits (take 3 of 4):
   - EE 447L (4)
   - EE 448 (3)
   - EE 478L (4)
   - EE 479L (4)
13. Integrated Circuits (take all 3):
   - EE/MASC 438L (3)
   - EE 448 (3)
   - EE 477L (4)

Non-EE Engineering
Science Elective:
At least one elective must be a non-EE engineering elective, either from these courses: CE 205, 225, 309, 325; CHE 472; ME 201, 310, 452, 453; or others by advisor approval.

Design Electives
(3 courses minimum):
At least three courses must be taken from the following design courses (one of which must be an asterisked capstone design course): EE 402, 434L*, 438L, 444L, 447L, 448, 454L*, 459L*, 473L, 477L*, 478L*, 479L.

Courses of Instruction
The terms indicated are expected but are not guaranteed. For the courses offered during any given term, consult the Schedule of Classes.

Electrical Engineering (EE)

101 Introduction to Digital Logic (3, FaSp) Boolean algebra; number systems; binary arithmetic; codes; gates; Boolean expressions; Boolean switching function synthesis; iterative arrays; sequential machines; state minimization; flip/flops; sequential circuits; simple processors.

102L Introduction to Digital Circuits (2, FaSp) Practical digital design using MSI/SSI TTL devices; practical aspects and specifications, open-collector/three-state outputs, timing and triggering; logical analyzers; finite state controllers; lab experiments; digital logic simulation. Prerequisite: EE 101.

103L Introduction to Microelectronics (2, Fa) Laboratory-intensive introduction to basic processes used to fabricate modern integrated circuits. Thin-film growth and deposition, photolithography, integrated-circuit packaging and testing. Process relationship to various disciplines of electrical engineering.

105 Introduction to Electrical Engineering (3, Sp) Gateway to the majors in Electrical Engineering. An overview of modern electrical engineering: communications, computers, circuits, components, controls, electromagnetics, microelectronics; principles of commercial products such as FAX, modem, copier, CD-ROM, ATM networks.

202L Linear Circuits (4, FaSp) Lumped circuit elements; network equations; zero-input and zero-state responses; sinusoidal steady-state analysis; impedance; resonance; network functions; power concepts; transformers; Laplace transforms. Prerequisite: PHYS 152L; corequisite: MATH 245.

241 Applied Linear Algebra for Engineering (3, FaSp) Introduction to the theory of matrices, vector spaces, least-squares approximation and MATLAB. Applications to communications, control and signal processing. Prerequisite: MATH 126.

301ab Introduction to Linear Systems (3-3, FaSp) a: Representation and analysis of linear time-invariant systems for the continuous time case. Convolution, Fourier series and transform, Laplace transform, controls and communication applications. Prerequisite: EE 202; corequisite: MATH 445. b: Discrete-time signals and systems, including difference equations, z-transforms, discrete-time Fourier series and transforms, sampling, filtering, digital control and modulation; state-variable models; uncertainty. Prerequisite: EE 301a; corequisite: EE 364.
302L Physical Optics (4, Sp) Wave nature of light, diffraction, interference, polarization, coherence, double refraction, optical activity, electro- and magneto-optics, absorption, scattering, dispersion, line spectra, laser phenomena. Lecture, 3 hours; discussion, 1 hour; laboratory, 3 hours. Prerequisite: PHYS 153L or PHYS 162L.


348L Electronic Circuits (4, FaSp) Basic analog and digital circuit design using Bipolar Junction Transistors, Field Effect Transistors and integrated circuits. Prerequisite: EE 338.

357 Basic Organization of Computer Systems (3, FaSpSm) Organization and operation of the processor, memory and I/O of a minicomputer at the machine language level; assembly language programming; data representation and computer arithmetic. Prerequisite: EE 101, EE 102, and a high level programming language.

364 Introduction to Probability and Statistics for Electrical Engineering (3, FaSp) Introduction to concepts of randomness and uncertainty: probability, random variables, statistics. Applications to digital communications, signal processing, automatic control, computer engineering. Prerequisite: MATH 245.

401 Transform Theory for Engineers (3, FaSp) Complex variables, Cauchy-Riemann conditions, contour integration and residue theory; Fourier transform; Laplace transform; sampling theory. Discrete time filters, discrete and fast Fourier transform. Prerequisite: EE 301a and MATH 445.


437 Fundamentals of Solid State (3) (Enroll in MASC 437)

438L Processing for Microelectronics (3) Applications and electrical evaluation of selected processes used in electronic microfabrication. Duplicates credit in former MASC 438L. Prerequisite: EE 338.

439 Principles of Semiconductor Processing (3) (Enroll in MASC 439)

440 Rotating Electric Machinery (3) Basic concepts of machine performance; poly-phase synchronous and induction machines; fractional horsepower AC motors, self-synchronous motors and systems; and dynamics of electromechanically coupled systems. Prerequisite: EE 370.

441 Applied Linear Algebra for Engineering (3, FaSpSm) Introduction to linear algebra and matrix theory and their underlying concepts. Applications to engineering problems. Prerequisite: MATH 445.

442 Direct Energy Conversion (3) Fundamentals of direct energy conversion methods. Principles governing conversion by chemical, thermionic, thermolectric, nuclear, and gas dynamic processes. Prerequisite: PHYS 152L, MATH 226.


444L Introduction to High-Efficiency Power Conversion (4) Linear and switching power converters and inverters; transformers, inductors, regulators, thermal design, power rectifiers and transistors, filters, current limiting, overvoltage protection, integrated circuits. Laboratory. Prerequisite: EE 348L.

445 Introduction to Robotics (3) (Enroll in CSCI 445)

447L Mixed Signal Electronic Circuits (4) Application of solid-state electronic devices to the design of linear and mixed-signal systems. Laboratory experiments and projects involving the design of electronic hardware. Prerequisite: EE 348L.
448 Electronic Circuits II (3) Fundamental network and semiconductor device modeling theories applied to the design and computer simulation of wideband analog and high-speed digital integrated circuits. Prerequisite: EE 348L.

450 Introduction to Computer Networks (3) Network architectures; layered protocols, network service interface; local networks; long-haul networks; internal protocols; link protocols; addressing; routing; flow control; higher level protocols. Prerequisite: junior standing.

454L Introduction to Systems Design Using Microprocessors (4, FaSpSm) Operation and timing of 8-bit microprocessors; design of microprocessor-based systems; 16-bit microprocessors; bit sliced microprocessors. Prerequisite: EE 102L and EE 357.

455x Introduction to Programming Systems Design (4) (Enroll in CSCI 455x)

457Lx Computer Systems Organization (3, FaSpSm) Register transfer level machine organization; CPU data paths and control; micro-programming; timing, simple arithmetic units; basic I/O organization; design using register transfer languages. Not available for graduate credit to computer science majors. Recommended preparation: EE 357, EE 102L.

459L Senior Design Project (3, Sp) Design, implementation and test of a computer hardware project; architecture, I/O interfaces, application specific hardware; presentation and demonstration. Prerequisite: EE 454L or EE 457Lx.

460 Introduction to Artificial Intelligence (3) (Enroll in CSCI 460)

464 Probability Theory for Engineers (3, FaSpSm) Axiomatic foundations of probability, random variables, Gaussian and Poisson distributions, functions of a random variable. Gaussian random vector, functions of several random variables; sequences of random variables. Prerequisite: EE 301a and MATH 445.

465 Probabilistic Methods in Computer Systems Modeling (3, Fa) Review of probability; random variables; stochastic processes; Markov chains; and simple queueing theory. Applications to program and algorithm analysis; computer systems performance and reliability modeling. Prerequisite: MATH 407.

467x Introduction to Communication Systems (3) Analog and digital communication systems. Modulation (AM, FM) coding, multi-plexing, noise, error rates, spectral analysis and power. Review of satellite, HDTV, mobile and fiber-optic systems. Not available for degree credit to students in the Communication Theory track in the Ph.D. in Electrical Engineering program. Prerequisite: EE 301a.

469 Introduction to Digital Media Engineering (3) Fundamentals of digital media representation, for audio, images and video signals. Sampling; Fourier and z-transforms; FFT; filter design; image segmentation, image and video compression standards. Prerequisite: EE 301a or EE 321; EE 364 or MATH 407.

470 Electromagnetics II (3) Dynamic field theory and elementary solutions to Maxwell’s equations. Introduction to propagation and radiation of electromagnetic fields. Prerequisite: EE 330.

471 Applied Quantum Mechanics for Engineers (3) Introductory quantum mechanics and applications. Schrodinger equation, atomic and molecular processes, time-dependent perturbation theory. Applications to lasers, solid state, gaseous devices. Prerequisite: EE 330 or graduate standing.

472 Introduction to Lasers and Laser Systems (3) Electric dipole transitions; traveling wave and resonant amplifiers; laser pumping and rate equations; threshold, frequency, and power output of lasers; holography; laser communication systems.

473L Lasers and Optics Laboratory (3) Introductory design/research laboratory in lasers and optics, which typically includes fiber optics, photonics, electro-optics, optical sensors, optical communication, optical signal processing and computing. Corequisite: EE 470 or consent of instructor.

474 Introduction to Photonics (3, Sp) Photonic system requirements; waveguide modes and dispersion; optical fiber modes, loss and dispersion; principles of operation of lasers, optical amplifiers, detectors and modulators; noise. Prerequisite: EE 330, EE 338.

475 Wireless Communication Technology (3, Fa) Fundamentals of wireless communication from a device point of view. Lab experiments and design project. Recommended preparation: EE 241, EE 301b.

476 Chemical Engineering Materials (3, Sp) (Enroll in CHE 476)

477L MOS VLSI Circuit Design (4, Fa) Analysis and design of digital MOS VLSI circuits including area, delay and power minimization. Laboratory assignments including design, layout, extraction, simulation and automatic synthesis. Prerequisite: EE 327x or EE 338.

478L Digital Electronic Circuit Design (4, Sp) Design of digital electronic circuits. Laboratory experiments and an extensive term project using digital hardware. Prerequisite: EE 348L.

479L Introduction to Integrated Circuit Design (4) Discussion of bipolar and MOS fabrication principles and IC layout guidelines. Discussion of broadbanded bipolar IC’s and MOS circuit transient switching response. Laboratory. Prerequisite: EE 348L.

482 Linear Control Systems (3, FaSpSm) Analysis of linear control systems; continuous and sampled-data systems, various stability criteria; frequency response and root locus compensation techniques. Prerequisite: EE 301a or graduate standing.


484 Communication System Design (3, Sp) Design and analysis of analog and digital communication systems. System models, requirements, development, performance analysis and component selection techniques. Comprehensive system design project. Prerequisite: EE 364, EE 475; recommended preparation: EE 467.
### Graduate Courses

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<td>533ab</td>
<td>Mixed-Signal VLSI Systems Design (3, Fa; b: 3, Sp)</td>
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<td>542</td>
<td>Advanced Power System Protection (3)</td>
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<td>543abL</td>
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<td>550</td>
<td>Design and Analysis of Computer Communication Networks (3, Fa)</td>
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<td>551</td>
<td>Principles of Radar (3, Sp)</td>
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552 Logic Design and Switching Theory (3, FaSpSm)
553 Computational Solution of Optimization Problems (3, Sp)
554 Real Time Computer Systems (3, Sp)
555 Broadband Network Architectures (3, FaSp)
556 Stochastic Optimization (3)
557 Computer Systems Architecture (3, FaSpSm)
558 Optical Fiber Communication Systems (3)
559 Mathematical Pattern Recognition (3, Fa)
560 Digital System Design-Tools and Techniques (3, Fa)
561ab Artificial Intelligence (3-3, FaSp)
562ab Random Processes in Engineering (3-3, FaSpSm)
563 Estimation Theory (3, Fa)
564 Communication Theory (3, FaSp)
565ab Information Theory (a: 3, Fa; b: 3, Sp)
566 Optical Information Processing (3, Fa)
567 Communication Systems (3, Fa)
568 Error Correcting Codes (3, Sp)
569 Introduction to Digital Image Processing (3, FaSp)
570ab Advanced Electromagnetic Theory (3-3)
571ab Microwave Networks (3-3)
572ab Plasma Dynamics (3-3)
573ab Antenna Analysis (3-3)
574 Computer Vision (3, Fa)
575 Application of Method of Moments to Electromagnetic Problems (3)
576 Analytical Techniques for Electromagnetic Theory (3)
577ab VLSI System Design (a: 3, Fa; b: 2, Sp)
578 Reflector Antennas (3)
579 Graph and Combinatorial Algorithms (3)
580 Optical Communications (3, Sp)
581 Sonar Signal Processing (3, Sp)
582 Technical Seminar on VLSI Design (1)
583 Adaptive Signal Processing (3, FaSp)
584 Chaotic Systems (3, Fa)
585 Linear System Theory (3, FaSpSm)
586L Advanced DSP Design Laboratory (4)
587 Nonlinear and Adaptive Control (3, Fa)
588 Linear Quadratic Control (3, Sp)
589 Statistical Optics (3, FaSp)
590 Directed Research (1-12, FaSpSm)
593 Multivariable Control (3, Fa)
594abz Master’s Thesis (2-2-0, FaSpSm)
595 Algebraic Coding Theory (3, Fa)
596 Wavelets (3, Fa)
597 Microsystems Technology for Multimedia (3, Fa)
598 Expert Systems (3)
599 Special Topics (2-4, max 9)
601 Semiconductor Devices (3)
604 Microwave Solid State Devices (3)
605 Heterojunction Materials and Devices (3)
606 Nonequilibrium Processes in Semiconductors (3)
607 Microelectromechanical Systems (3, FaSp)
608 Microelectromechanical Systems Laboratory (3, Fa)
609 Selected Topics in Digital Image Processing (3, Sp)
610 Advanced Topics in Automatic Speech Recognition (3, Sp)
619 Advanced Topics in Automatic Speech Recognition (3, Sp)
620 Advanced Electrical Circuit Theory (3)
642 Advanced Geometrical Optics (3)
650 Advanced Topics in Computer Networks (3, Irregular)
653 Multithreaded Architectures, Data-Flow Computing and Functional Programming (3, Fa)
657 Parallel Processing (3, FaSp)
658 Diagnosis and Design of Reliable Digital Systems (3, Fa)
659 Interconnection Networks (3, Fa)
663 Satellite Communications (3)
664 Advanced Topics in Communication Theory (3, 2 yrs, Sp)
666 Data Communication (3, Irregular)
667 Array Signal Processing (3, Sp)
668 VLSI Array Processors for Signal Processing (3, Irregular)
669 Selected Topics in Digital Image Processing (3, Sp)
674ab Advanced Topics in Computer Vision (3-3, Irregular)
677 VLSI Architectures and Algorithms (3)
680 Computer Aided Design of Digital Systems I (3, Sp)
681 Computer-Aided Design of Digital Systems II (3)
683 Modern Spectral Analysis (3, Irregular)
689 Optical Computing Systems (3, Sp)
690 Directed Research (1-4, max 8, FaSpSm)
700 Research (1-12, FaSpSm)
790 Research (1-12, FaSpSm)
794abcdz Doctoral Dissertation (2-2-2-2-0, FaSp)
electrical engineering (131 units)

**Freshman (16 units)**
- GE Cat. VI (4)
- WRIT 140 (4)
- MATH 125 (4)
- CHEM 105aL or MASC 110L (4)

**Sophomore (15 units)**
- GE Cat. I (4)
- CSCI 101L (3)
- MATH 126 (4)
- PHYS 151L (4)
- EE 105 (3)

**Junior (16 units)**
- TECH. ELEC. (3)
- MATH 226 (4)
- PHYS 152L (4)
- EE 301a (3)

**Senior (16 units)**
- TECH. ELEC. (3)
- TECH. ELEC. (4)
- TECH. ELEC. (4)

**Mathematics (20 units)**
- MATH 125 — Calculus I
- MATH 126 — Calculus II
- MATH 226 — Calculus III
- MATH 245 — Mathematics of Phys. and Engr. I
- MATH 445 — Mathematics of Phys. and Engr. II

**Physics (12 units)**
- PHYS 151L — Mechanics and Thermodynamics
- PHYS 152L — Electricity and Magnetism
- PHYS 153L — Optics and Modern Physics

**Chemistry / Materials Science (4 units)**
- CHEM 105aL* — General Chemistry
- or
- MASC 110L — Materials Science

**General Education (27 units)**
- WRIT 140** — Writing and Critical Reasoning
- WRIT 340 — Advanced Writing
- GE Cat. I, II, V, VI
- or
- MASC 110L — Materials Science

**Engineering (68 units)**
- CSCI 101L — Fund. of Comp. Programming
- EE 101 — Introduction to Digital Logic
- EE 105 — Intro. to Electrical Engineering
- EE 202L — Linear Circuits
- EE 301a — Introduction to Linear Systems
- EE 330 — Electromagnetics I
- EE 364 — Intro. to Probability & Statistics
- ISE 460 — Engineering Economy
- or
- BUAD 301 — Technical Entrepreneurship

**Electives (see below)**
- Technical Elective (see below)
- Technical Elective (see below)
- Technical Elective (see below)
- Technical Elective (see below)
- Technical Elective (see below)
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- Technical Elective (see below)

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* Advanced students with departmental approval have the option of completing CHEM 115aL in place of CHEM 105aL.

**Concurrent enrollment in a Social Issues GE Course is required.

*** May take Category I, II, IV or VI GE class.

**** A list of acceptable elective courses may be found on pages 62-63. This information is also available directly from the Electrical Engineering department. Keep in mind that the above distribution of electives is common, but by no means the only distribution possible. Refer to specific elective lists for full details.
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