

# ELECTRICAL ENGINEERING

Phone: (209) 946-2153

Location: Anderson Hall

Website: Electrical Engineering (<https://engineering.pacific.edu/engineering/academics/electrical-engineering/>)

## Degrees Offered

Bachelor of Science in Electrical Engineering

## Electrical Engineering Program Educational Objectives

Through their careers in electrical engineering or related profession, Pacific graduates are expected to demonstrate the following within a few years of earning their Bachelor's degree in Electrical Engineering:

- Competency in the electrical engineering profession via promotion to positions of increasing responsibility, publications, and/or conference presentations
- Adaptability to new developments in science and technology by successfully completing or pursuing graduate education in engineering or related fields, participating in professional development and/or industrial training courses, or pursuing professional licensure

### Students graduating with a BS in Electrical Engineering will have:

- an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- an ability to communicate effectively with a range of audiences
- an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

## Bachelor of Science in Electrical Engineering

Students must complete a minimum of 120 units of academic work and a minimum of 32 units of Cooperative Education in order to earn the bachelor of science in electrical engineering.

### I. General Education Requirements

For more details, see General Education (<http://catalog.pacific.edu/stocktongeneral/generaleducationprogram/>)

Minimum 28 units and 9 courses that include:

### A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

**Note: 1)** CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

### B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning
Scientific Inquiry
Social Inquiry
World Perspectives & Ethics

**Note: 1)** No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

### C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

**Note: 1)** Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

### D. Fundamental Skills

Students must demonstrate competence in:

Writing
Quantitative Analysis (Math)

**Note: 1)** Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

## II. Major Requirements

### Mathematics and Science (minimum of 30 units)

MATH 051	Calculus I	4
MATH 053	Calculus II	4
MATH 055	Calculus III	4
MATH 057	Applied Differential Equations I: ODEs	4
PHYS 053	Principles of Physics I	5
PHYS 055	Principles of Physics II	5
ECPE 127	Random Signals	3

Select one of the following math courses: 4

MATH 075	Introduction to Linear Algebra
MATH 110	Numerical Analysis
MATH 145	Applied Linear Algebra
MATH 148	Cryptography
MATH 152	Vector Analysis
MATH 155	Real Analysis I
MATH 157	Applied Differential Equations II
MATH 174	Graph Theory

### Engineering Science

IDEA 010	Interdisciplinary Design and Success *	2
IDEA 020	Interdisciplinary Design and Innovation *	2
ECPE 041	Circuits	3
ECPE 041L	Circuits Laboratory	1
ECPE 071	Digital Design	3
ECPE 071L	Digital Design Lab	1
ENGR 030	Engineering and Computing Ethics in Society	3

#### Electrical Engineering Core

COMP 051	Introduction to Computer Science	4
COMP 053	Data Structures	4
ECPE 121	Digital Signal Processing	4
ECPE 131	Electronics	4
ECPE 141	Advanced Circuits	4
ECPE 172	Microcontrollers	4
ECPE 195	Senior Project I	2
ECPE 196	Senior Project II	2
ENGR 025	Professional Practice Seminar	1
Select one of the following:		4
ECPE 144	Applied Electromagnetics	
PHYS 101	Electricity and Magnetism	

#### Technical Electives

Select two of the following:		6-8
ECPE 124	Digital Image Processing	
ECPE 133	Solid State Devices	
ECPE 135	Power Electronics	
ECPE 136	VLSI Design	
ECPE 161	Automatic Control Systems	
ECPE 162	Communication Systems	
ECPE 163	Energy Conversion	
ECPE 165	Power System Analysis	

#### ECPE Electives

Select two of the following:		6-8
Any 100 or 200 level ECPE course		
BENG 171	Bioelectricity	
BENG 175	Human/Brain Machine Interface	
IDEA 130	Introduction to Mobile Robotics	
IDEA 131	Autonomous Mobile Robotics	

#### SOECS Elective

Select one course from BENG, CIVL, COMP, ECPE, ENGR, EMGT, EPHY, IDEA or MECH \*\*

#### Cooperative Education (minimum of 32 units)

ENGR 181	Professional Practice	1-16
ENGR 182	Professional Practice	1-16
ENGR 183	Professional Practice	1-16

\* Students who transfer in with 28 or more units are exempt from taking IDEA 010 and IDEA 020.

\*\* For SOECS elective, ECPE, EPHY, or COMP courses must be at 100 or 200 level. Excluding: COMP 187, ENGR 010, ENGR 019, ENGR 025, ENGR 030, ENGR 181, ENGR 182, ENGR 183, IDEA 010, IDEA 020, and IDEA 132.

## Electrical Computer Engr Courses

### ECPE 005. Introduction to Electrical and Computer Engineering. 1 Unit.

This course introduces students to various sub-disciplines of Electrical and Computer Engineering and to the tools, both hardware and software, that are used in Electrical & Computer Engineering. Prerequisite that may be taken concurrently: ENGR 010 with a "C-" or better.

### ECPE 041. Circuits. 3 Units.

Students study concepts of voltage, current, power, energy. Topics include ideal circuit elements and their I/V characteristics, Kirchhoff's laws, circuit analysis using node voltage and mesh current methods Thevenin's and Norton's theorems, maximum power transfer, and operational amplifier circuits. The course examines step response of 1st order (RC, RL) and 2nd order (RLC) circuits, phasor analysis, impedance calculations, sinusoidal steady state response, instantaneous, average, and reactive power, frequency response, bandwidth of first order, and lowpass and highpass filters. Prerequisites: PHYS 055; MATH 055; COMP 061 or COMP 051 or ENGR 019 with a "C-" or better. Prerequisites that may be taken concurrently: PHYS 55, MATH 55.

### ECPE 041L. Circuits Laboratory. 1 Unit.

Students study the use of standard test equipment to make DC and AC measurements and characterize electric circuits. Circuit simulation is taught with software tools, and data analysis is emphasized. Corequisite: ECPE 041.

### ECPE 071. Digital Design. 3 Units.

Students study number systems, binary arithmetic, and Boolean logic. Topics include the analysis and synthesis of combinational and sequential circuits and the use of FPGA devices. Prerequisites: Fundamental Math Skills requirement, and Sophomore or Junior or Senior standing.

### ECPE 071L. Digital Design Lab. 1 Unit.

This course involves laboratory treatment of the concepts discussed in ECPE 071. Corequisites: ECPE 071. Prerequisites: Fundamental Math Skills requirement; COMP 051 or COMP 061 or ENGR 019 with a "C-" or better.

### ECPE 121. Digital Signal Processing. 4 Units.

Students analyze discrete-time signals and systems using z transforms and Fourier transforms, the fast Fourier transform and its applications, digital filters and their applications and implementation of DSP algorithms using Matlab and Simulink. Also listed as BENG 121. Prerequisites: ECPE 041 and MATH 057 with a "C-" or better.

### ECPE 124. Digital Image Processing. 4 Units.

This course is the analysis and design of algorithms in digital image processing. Topics include: image formation, file format, pixel-based processing, object recognition, filtering and edge detection, image transforms, segmentation, stereo-vision, and motion tracking. Prerequisites: COMP 053, ECPE 121 with a "C-" or better. Prerequisite that may be taken concurrently: ECPE 121.

### ECPE 127. Random Signals. 3 Units.

This course is an introduction to probability and statistics in engineering applications. Students will become familiar with discrete and continuous random variables and their probability models. Topics include counting methods, reliability problems, probability mass functions (PMF), probability density functions (PDF), cumulative distribution functions (CDF), conditional PDF's, expected value and variance, joint and marginal PDF's and CDF's, functions of two random variables, sampling distributions, population parameter estimation, hypothesis testing using statistical software. Prerequisites: Completion of all Fundamental Skills, MATH 055 with a "C-" or better.

**ECPE 131. Electronics. 4 Units.**

Introduction to semiconductor physics, devices, and their circuit models. Analysis, design, implementation, testing, and verification of practical analog and digital circuits containing diodes, bipolar junction transistors, and field effect transistors. Extensive use of computer-aided analysis and design software. The course includes a laboratory. Prerequisites: Completion of all Fundamental Skills; ECPE 041, ECPE 041L, ECPE 071, ECPE 071L, MATH 055, PHYS 055, with a "C-" or better; AP CHEM with score of 4 or higher, or IB CHEM Higher Level with score of 5 or higher, or one year of high school chemistry with a "B-" or better, or appropriate score on the Pacific Diagnostic Chemistry test or CHEM 023 with a "C-" or better. Prerequisite that may be taken concurrently: ECPE 071, ECPE 071L.

**ECPE 133. Solid State Devices. 4 Units.**

This course introduces concepts related to the crystal structure of semiconductors and electronic, optical, and magnetic properties of semiconductors. Dynamics of carriers under equilibrium and non-equilibrium conditions are presented as a frame work for understanding the behavior of a number of devices including Metal-Oxide-Semiconductor (MOS) and Hetero-junction Bipolar (HBT) devices. On such a background, the course builds an understanding of the latest advances in the field. This course is cross listed with EPHY 133 and PHYS 170. Prerequisite: PHYS 055 with a "C-" or better. Prerequisite that may be taken concurrently: MATH 057 with a "C-" or better.

**ECPE 135. Power Electronics. 4 Units.**

Switch-Mode DC-DC converters, Feedback control of converters, Rectifiers and power factor correction circuits, switch mode DC power supplies, applications to motor control and renewable energy integration to the grid. Includes laboratory. Prerequisites: Completion of all Fundamental Skills; ECPE 131 with a "C-" or better. Prerequisites that may be taken concurrently: ECPE 121 or ECPE 141 with a "C-" or better.

**ECPE 136. VLSI Design. 4 Units.**

Students examine issues in VLSI design. Topics include logic families, sizing, timing models, fabrication, layout, high speed and low power design tradeoffs, circuit simulation and device modeling. (Spring odd years). Prerequisites: Completion of all Fundamental Skills; ECPE 071, ECPE 071L, ECPE 131 with a "C-" or better.

**ECPE 141. Advanced Circuits. 4 Units.**

Analysis and design of circuits in the continuous time domain. Topics include: frequency response, Laplace transforms, Fourier transforms, stability and feedback. Applications include high-order filter design and controls. Prerequisites: ECPE 041, ECPE 041L, and MATH 057 with a "C-" or better.

**ECPE 144. Applied Electromagnetics. 4 Units.**

The purpose of this course is for students to gain an understanding of transmission lines and field theory as it applies to communication circuits and systems. Electromagnetic wave propagation, reflection, and transmission through common materials are examined. This course is cross listed with EPHY 144. Prerequisites: Completion of all Fundamental Skills; PHYS 055, MATH 057, with a "C-" or better.

**ECPE 155. Autonomous Robotics. 4 Units.**

This course is an overview of the design of autonomous robotics. Students study architectures for robot organization and control, configurations of fixed and mobile robots, sensors and actuators. Students also study the design of algorithms and knowledge representations. Prerequisites: Completion of all Fundamental Skills; COMP 053 and ECPE 172 with a "C-" or better or permission of instructor.

**ECPE 161. Automatic Control Systems. 4 Units.**

Students study component and system transfer functions, open and closed loop response; stability criteria; applications to engineering systems. this course include a laboratory. Prerequisites: Completion of all Fundamental Skills; Prerequisite that may be taken concurrently: ECPE 121 or ECPE 141.

**ECPE 162. Communication Systems. 4 Units.**

Students examine signal characterization in time and frequency domains. Topics include baseband communication, pulse code modulation, multiplexing, complex envelope representation of bandpass signals. AM, FM, and digital modulations. Students also examine applications to radio, television, telephone, and cellular phone systems. A laboratory is included. Prerequisites: Completion of all Fundamental Skills and ECPE 121 with a "C-" or better. (Spring).

**ECPE 163. Energy Conversion. 4 Units.**

Students study three phase power systems. Topics include magnetic circuits, transformers, rotating machines: DC, induction, and synchronous machines as well as equivalent circuits and characteristic curves of transformers and rotating machines, renewable energy sources and technologies. the course includes a laboratory. Prerequisites: Completion of all Fundamental Skills; ECPE 041 and ECPE 041L; PHYS 055 with a "C-" or better.

**ECPE 165. Power System Analysis. 3 Units.**

Students study electrical power generation and transmission, Three-phase systems, power system component models, per-unit system and single line diagrams, power flow analysis. Prerequisites: Completion of all Fundamental Skills and ECPE 041 with a "C-" or better. Junior standing.

**ECPE 170. Computer Systems and Networks. 4 Units.**

The course investigates the operation of a modern computer system and its components. Students examine the processor data path and memory hierarchy by writing assembly programs and high-level simulations. The course also provides an introduction to computer networks and socket programming. Prerequisites: Completion of all Fundamental Skills; ECPE 071 or COMP 047 with a "C-" or better; COMP 053 with a "C-" or better.

**ECPE 172. Microcontrollers. 4 Units.**

Students study the design and implementation of digital monitoring and control systems that use micro-controllers. Topics include hardware and software development, interfacing input and output devices, assembly and C programming as well as representative applications. The course includes a laboratory. Prerequisites: Completion of all Fundamental Skills; COMP 053, ECPE 071, and ECPE 071L with a "C-" or better.

**ECPE 173. Computer Organization and Architecture. 3 Units.**

The objective of this course is to give students a deeper understanding of how a complete modern computer system operates. Students learn about design of a processing unit, pipelining, memory hierarchy, parallelism, and more advanced architecture topics. Prerequisites: Completion of all Fundamental Skills; ECPE 071L and ECPE 170 with a "C-" or better.

**ECPE 174. Advanced Digital Design. 4 Units.**

Students learn how to analysis, design, and implement synchronous state machines using programmable logic devices. Topics include CAD-based simulation and development that use schematic capture and hardware description languages, and representative applications. The course includes a laboratory. Prerequisites: Completion of all Fundamental Skills; ECPE 071 and ECPE 071L with a "C-" or better.

**ECPE 177. Computer Networking. 4 Units.**

Topics examined in this course include computer networks and the internet, LAN and WAN architectures, and packet switched networks and routing. Students learn about the internet protocol stack, socket programming and client/server systems, wireless networking and security. Also listed as COMP 177. Junior or Senior standing. Prerequisites: Completion of all Fundamental Skills; COMP 053 and ECPE 170 with a "C-" or better.

**ECPE 178. Computer Network Security. 3 Units.**

This course is an examination of computer security from a defensive and offensive perspective. Topics include attack methods used by threat actors (including scanning, exploits, privilege escalation, malware, and social engineering methods), their detection, and their prevention by network and host-based techniques. Additionally, cryptographic techniques are introduced in order to provide secure communications channels that guarantee message confidentiality, authenticity, and integrity. Prerequisites: Completion of all Fundamental Skills and ECPE 170 or COMP 175 with a "C-" or better.

**ECPE 191. Independent Study. 1-4 Units.**

Special individual projects are undertaken under the direction of one or more faculty members knowledgeable in the particular field of study. Permission of department chairperson and faculty members involved.

**ECPE 195. Senior Project I. 2 Units.**

This first semester capstone design course instructs students in the application of design processes and interdisciplinary teamwork. Student teams select a project and develop requirements, test, and design documents. Projects incorporate consideration of engineering standards and realistic constraints such as economics, the environment, sustainability, manufacturability, or safety. Components are evaluated and selected. Feasibility is analyzed through prototyping or simulation and results are presented via oral and written reports. This course is cross listed with EPHY 195. Prerequisites: Completion of all Fundamental Skills; ECPE 131 with a "C-" or better.

**ECPE 196. Senior Project II. 2 Units.**

This second-semester capstone design course, interdisciplinary teams complete the design of their projects. Full implementation is completed, including iteration, optimization, and refinement; justifications for design decisions are analyzed. Testing is performed and results are evaluated to demonstrate satisfaction of specifications. Final oral and written reports, complete documentation, and a project demonstration are required. This course is cross listed with EPHY 196. Prerequisites: Completion of all Fundamental Skills; ECPE 195 with a "C-" or better.

**ECPE 197. Undergraduate Research. 1-4 Units.**

This course offers applied or basic research in electrical and/or computer engineering under faculty supervision. Permission of faculty supervisor and department chair. The student must be in good academic standing.