ELECTRICAL ENGINEERING

Department Website: Electrical Engineering (https://www.gonzaga.edu/school-of-engineering-applied-science/degrees-and-programs/electrical-engineering/)

The purpose of the electrical engineering (EE) and computer engineering (CpE) programs is to develop knowledgeable and competent engineering professionals who exemplify the humanistic, Catholic, and Jesuit tradition of education, and who are committed to social justice, service to others, life-long learning, ethical and moral responsibility, and concern for the environment. The integration of the Gonzaga University core curriculum as an essential part of the EE and CpE curricula gives the programs their distinct and desirable characteristics.

Roughly half of the credits in either the EE or the CpE program are devoted to engineering topics and design. While the EE program offers five technical electives, the CpE program provides four technical electives, allowing students to pursue specialization in one or more areas of electrical engineering and/or computer engineering. During their final year, students complete a design project, which involves both technical and non-technical aspects of an engineering problem, under faculty supervision. The senior design project culminates in a comprehensive written report and an oral presentation.

Career Opportunities

Graduates of our EE and CpE programs are well prepared to embark on careers in electrical engineering or computer engineering, or to further their education at graduate schools of their choice. Our graduates find employment with a broad segment of industry, as well as with governmental agencies. Employment opportunities include the design of electronic products, design of electrical systems, development of computer, hardware, software/firmware, robots, artificial intelligence (AI), computer applications, research and development, engineering consulting, electrical utilities, manufacturing, marketing, operations and maintenance, administration, and teaching. Moreover, electrical and computer engineers traditionally engage in interdisciplinary fields, such as aerospace engineering, national defense systems, global communication systems, biomedical engineering, instrumentation, transportation systems, energy conversion, robotics, and industrial automation. Many of our graduates have distinguished themselves at some of the best graduate schools in the USA. Moreover, a substantial number of our graduates have achieved high positions in academia, business, and government.

Electrical Engineering Program Requirements

Course	Title	Hours
First Year		
Fall		
CHEM 101	General Chemistry I	3
CHEM 101L	General Chemistry I Lab	1
DEPT 193	FYS:	3
MATH 157	Calculus and Analytic Geometry I	4
PHIL 101	Reasoning	3
COMM 100	Communication and Speech	3
	Hours	**17**
Spring		
ENGL 101	Writing	3
CPSC 121	Computer Science I	3
MATH 258	Calculus and Analytic Geometry II	4
CPEN 230	Introduction Digital Logic	3
CPEN 230L	Introduction Digital Logic Lab	1
PHIL 201	Philosophy of Human Nature	3
	Hours	**17**
Second Year		
Fall		
CPEN 231	Embedded Computer Systems	3
CPEN 231L	Embedded Computer Systems Lab	1
PHYS 121	Physics I	4
PHYS 121L	Physics I Lab	1
EENG 201	Circuit Analysis I	3
EENG 201L	Circuit Analysis I Lab	1
Core Broadening Requirement		3
	Hours	**16**
Spring		
EENG 202	Circuit Analysis II	3
MATH 259	Calculus and Analytic Geometry III	4
PHYS 122	Physics II	4
PHYS 122L	Physics II Lab	1
Religion Requirement: Christianity and Catholic Traditions		3
	Hours	**15**
Third Year		
Fall		
EENG 301	Electro Fields and Materials	3
EENG 303	Electronics Design I	3
EENG 303L	Electronics Design I Lab	1
EENG 311	Signals and Systems I	4
MATH 260	Ordinary Differential Equation	3
Ethics core requirement		3
	Hours	**17**
Spring		
EENG 304	Electronics Design II	3
EENG 304L	Electronics Design II Lab	1
EENG 322	Signals and Systems II	3
EENG 340	Introduction Electric Power Engineering	3
EENG 340L	Introduction Electric Power Engineering Lab	1
Religion Requirement: World or Comparative Religion		3
DEPT 432	CIS:	3
	Hours	**17**
Fourth Year		
Fall		
EENG 411	Introduction to Control Systems	3
EENG 411L	Introduction to Control Systems Lab	1
EENG 421	Introduction Communication Systems	3
EENG 421L	Introduction to Communication Systems Lab	1
ENSC 491	Senior Design Project I	2
Technical elective [1]		3
Technical elective [1]		3
	Hours	**16**
Spring		
ENSC 492	Senior Design Project II	3
ENSC 400	Foundations of Engineering Exam	0
Technical elective [1]		3
Technical elective [1]		3
Technical elective [1]		3
Core Broadening Requirement: (History, Literature, Social and Behavioral Science)		3
	Hours	**15**
	Total Hours	**130**

[1] Approved EENG or CPEN elective courses

Technical Electives in Electrical Engineering

Only 300 and 400 level courses that are not required in the degree plan can be used to satisfy the technical elective requirements. The student's advisor must approve the selection and must contain courses from at least two of the following specializations:

1. Electromagnetics, Circuits, Electronics and Filters,
2. Control Systems and Automation,
3. Communication Systems and Signal Processing,
4. Electric Power and Power Systems Engineering, and
5. Computer Engineering.

Please see your advisor for current course offerings.

Electrical Engineering

Code	Title	Hours
EENG 401	Lower Power Bioelectronics	3
EENG 402	Electromag Waves and Materials	3
EENG 403	Passive and Active Filter Design	3
EENG 406	VLSI Circuits and Systems	3
EENG 410	Information Theory and Coding	3
EENG 412	Digital Control Systems	3
EENG 424	Digital Signal Processing	3
EENG 427	Wireless Systems	3
EENG 428	Wireless Systems II	3
EENG 441	Analysis of Power Systems	3
EENG 442	Electrical Power Distribution System in Engineering	3
EENG 443	Analysis of Electrical Machines	3

Computer Engineering

Code	Title	Hours
CPEN 342 & 342L	Cyber-Physical Systems and Cyber-Physical Systems Lab	4
CPEN 430 & 430L	Digital System Design and Digital System Design Lab	4
CPEN 431	Computer Hardware Design and Architecture	3
CPEN 435	Parallel & Cloud Computing	3
CPEN 436	Machine Learning in Biomed	3
CPEN 442	Introduction to Robotics	3
CPEN 443	Autonomous Mobile Robots	3

Engineering Science

ENSC 355 Thermal Science

ECE: Concentration in Robotics

The Department of Electrical and Computer Engineering offers a Concentration in Robotics.

This concentration is for students majoring in either the BSEE or the BSCpE degrees. A student majoring in one of these programs may pursue the concentration as they are not eligible for a minor in this area. The concentration course requirements are identical regardless of the degree a student is seeking.

Code	Title	Hours
CPEN 442	Introduction to Robotics	3
CPEN 443	Autonomous Mobile Robots	3
Select two of the following:		6
CPEN 436	Machine Learning in Biomed	
EENG 411	Introduction to Control Systems	
EENG 412	Digital Control Systems	
EENG 424	Digital Signal Processing	

Courses

EENG 193. FYS:. (3 Credits)
The First-Year Seminar (FYS) introduces new Gonzaga students to the University, the Core Curriculum, and Gonzaga's Jesuit mission and heritage. While the seminars will be taught by faculty with expertise in particular disciplines, topics will be addressed in a way that illustrates approaches and methods of different academic disciplines. The seminar format of the course highlights the participatory character of university life, emphasizing that learning is an active, collegial process.

EENG 201. Circuit Analysis I. (3 Credits)
Fundamental electrical laws; network theorems. Basic circuit elements: resistance, inductance, capacitance, independent and controlled sources, and op-amps. Techniques of circuit analysis; steady-state and transient responses; first-order and second-order circuits; complex numbers; sinusoidal analysis. Three lectures hours per week. Prerequisite: MATH 258.
Prerequisites: MATH 258 (may be taken concurrently)
Corequisites: EENG 201L

EENG 201L. Circuit Analysis I Lab. (1 Credit)
Three laboratory hours per week. Taken concurrently with EENG 201.
Corequisites: EENG 201

EENG 202. Circuit Analysis II. (3 Credits)
Continuation of EENG 201. Sinusoidal steady-state analysis; RMS value; real , reactive, and complex powers; balanced three-phase circuits; second-order circuits; frequency response; Bode plots; resonance; complex frequency; transfer functions; two-port circuits; magnetically coupled circuits; transformers.
Prerequisites: EENG 201 with a minimum grade of D

EENG 202L. Circuit Analysis II Lab. (0-1 Credits)
Equivalent: EE 202L

EENG 301. Electro Fields and Materials. (3 Credits)
Application of vector calculus to static and time-varying electric and magnetic fields; electromagnetic properties of conductors, insulators, dielectrics, and ferromagnetic materials; Maxwell's equations; electromagnetic waves; transmission lines. Four lecture hours per week. EENG 202 is a co-requisite or pre-requisite for this course.
Prerequisites: EENG 201 with a minimum grade of D and (PHYS 204 with a minimum grade of D or PHYS 122 (may be taken concurrently) with a minimum grade of D) and MATH 259 with a minimum grade of D

EENG 303. Electronics Design I. (3 Credits)
Introduction to electronics design concepts; semiconductor devices and their associated electrical behavior; amplifier modeling, design, and trade-offs; practical designing, building, testing, and analyzing of electronic circuits. Three lecture hours per week. EENG 202 is a co-requisite or pre-requisite for this course.
Prerequisites: EENG 201 with a minimum grade of D

EENG 303L. Electronics Design I Lab. (1 Credit)
Three laboratory hours per week. Taken concurrently with EENG 303.
Corequisites: EENG 303

EENG 304. Electronics Design II. (3 Credits)
Continuation of EENG 303. Frequency response and distortion; tuned circuits; operational amplifiers; power amplifiers; feedback concepts and oscillators; digital circuits; astable circuits; data conversion; practical design and application of electronic circuits. Three lecture hours per week.
Prerequisites: EENG 303 (may be taken concurrently) with a minimum grade of D and EENG 303L (may be taken concurrently) with a minimum grade of D
Corequisites: EENG 304L

EENG 304L. Electronics Design II Lab. (1 Credit)
Three laboratory hours per week. Taken concurrently with EENG 304.
Corequisites: EENG 304

EENG 311. Signals and Systems I. (4 Credits)
Signals and systems; types of signals; properties of systems; convolution integral; Fourier series; Fourier transform and applications; Laplace transform and applications; Sampling Theorem. Four lecture hours per week. EENG 202 and MATH 260 are co-requisites or prerequisites for this course.
Prerequisites: EENG 201 with a minimum grade of D

EENG 322. Signals and Systems II. (3 Credits)
Introduction to probability; random variables; multiple random variables; elements of statistics; applications in electrical and computer engineering. Three lecture hours per week.
Prerequisites: Prerequisites exist. Refer to Zagweb.

EENG 340. Introduction Electric Power Engineering. (3 Credits)
Magnetic circuits; principles of electromechanical energy conversion; transformers; synchronous machines; three-phase induction machines; D.C. machines; transmission lines; power system modeling; power flow analysis. Three lecture hours per week.
Prerequisites: EENG 201 with a minimum grade of D and EENG 202 (may be taken concurrently) with a minimum grade of D
Corequisites: EENG 340L

EENG 340L. Introduction Electric Power Engineering Lab. (1 Credit)
Three hours of laboratory per week. Taken concurrently with EENG 340.
Corequisites: EENG 340

EENG 401. Lower Power Bioelectronics. (3 Credits)
Physics and technology of semiconductor devices; Carrier transport phenomena; p-n junctions; Metal semiconductor junctions; Device operation based on junction physics; Process technologies; Some simulations using modern software. Three lecture hours per week.
Prerequisites: CPEN 230 with a minimum grade of D and EENG 303 with a minimum grade of D

EENG 402. Electromag Waves and Materials. (3 Credits)
Continuation of EENG 301. Time varying fields; electromagnetic waves and transmission lines; metallic waveguides and resonators; principles of photonics; antennas. Three lectures hours per week.
Prerequisites: EENG 301 with a minimum grade of D

EENG 403. Passive and Active Filter Design. (3 Credits)
Properties of network functions; properties and realizations of LC and RC driving point functions; passive realizations of transfer functions; Butterworth, Chebyshev, and Bessel filter approximations; design techniques for low-pass, high-pass, band-bass, and band-elimination filters. Basic building blocks for active filters; direct and cascade realization approaches. Three lecture hours per week.
Prerequisites: EENG 311 with a minimum grade of D

EENG 406. VLSI Circuits and Systems. (3 Credits)
Structural design of digital integrated circuits in MOS technology; layout, design rules, fabrication techniques; use of computer automated design and simulation tools, and high-level description language. Three lecture hours per week. EENG 304 is a co-requisite or pre-requisite for this course.
Prerequisites: CPEN 230 with a minimum grade of D and EENG 303 with a minimum grade of D

EENG 410. Information Theory and Coding. (3 Credits)
Discussion of the concepts of information transmission theory including entropy, redundancy, the noisy channel model and channel capacity. Basics of source coding including compression limits and Huffman codes. Linear block code discussion involving Hamming distance, error detection/correction capabilities, generator/parity-check matrices, syndromes and error correction. Well-known block codes such as Hamming codes and the Golay code. Basics of finite field algebra and BCH codes including Reed-Solomon codes. Convolutional codes and the Viterbi decoding algorithm. Concatenated codes and the NASA Deep Space Network telemetry system. Fall.
Enrollment limited to students with a semester level of Fourth Year (96+ credits) or Third Year (60-95.99 credits).

EENG 411. Introduction to Control Systems. (3 Credits)
Analysis and design of linear closed-loop systems; stability; design based on root locus and root contours. A package of computer programs is used for homework and design problems. Three lectures hours per week.
Prerequisites: EENG 201 with a minimum grade of D

EENG 411L. Introduction to Control Systems Lab. (1 Credit)
Experimental investigation of concepts and subsystems used in controls. Three laboratory hours per week. Taken concurrently with EENG 411
Corequisites: EENG 411

EENG 412. Digital Control Systems. (3 Credits)
Classical and modern control system analysis and design techniques. Sampling; stability; frequency response; root locus; state variables in discrete time; controllability; observability; state variable feedback; pole placement and observers. A package of computer programs is used for homework and a design project. Three lecture hours per week.
Prerequisites: EENG 411 with a minimum grade of D or MENG 411 with a minimum grade of D

EENG 413. Artificial Intelligence Powered Automation. (3 Credits)
The new one: Concepts and components of industrial automation and control; automation logic design; programmable logic controller (PLC) circuits and design; Generative AI algorithms and PLC; Reinforcement Learning and its application in control; AI-based solution in predictive maintenance.
Prerequisites: CPSC 121 with a minimum grade of D or ENSC 201 with a minimum grade of D

EENG 421. Introduction Communication Systems. (3 Credits)
Basic concepts in communication systems: correlation and power spectral density; pulse modulation; amplitude modulation; angle modulation; effects of noise. Three lecture hours per week.
Prerequisites: EENG 311 with a minimum grade of D

EENG 421L. Introduction to Communication Systems Lab. (1 Credit)
Experimental investigation of concepts and subsystems used in electronic communications. Taken concurrently with EENG 421.
Corequisites: EENG 421

EENG 424. Digital Signal Processing. (3 Credits)
Discrete Fourier Transform and circular convolution; Fast Fourier Transform; use of windows in spectral estimation; filter approximations; design and realization of IIR and FIR digital filters; effects of finite word size; sampling rate conversion. Three lecture hours per week.
Prerequisites: EENG 311 with a minimum grade of D

EENG 427. Wireless Systems. (3 Credits)
Fundamentals of RF stages of modern wireless systems including antennas, propagation, fading, noise, receiver design, modulation methods and bit error rates. Components of wireless systems, including filters, amplifiers, mixers, oscillators, and phase-locked loops. Initial coverage includes transmission lines, S-parameters, impedance matching, and random processes. Three lecture hours per week.
Prerequisites: EENG 202 with a minimum grade of D

EENG 428. Wireless Systems II. (3 Credits)
Advanced topics in modern RF/microwave wireless component design including microstrip transmission lines, filters and amplifiers. Mixer, oscillator and phase-locked loop basics. Digital modulation methods and bit error rates. Introduction to information capacity. Receiver design. Three lecture hours per week.
Prerequisites: EENG 427 with a minimum grade of D

EENG 441. Analysis of Power Systems. (3 Credits)
Per unit system; transmission line parameters; power system models; generators, transformers, lines, loads; power flow problem and solution methods; symmetrical components; symmetrical and unsymmetrical fault analysis; use of computer software package to solve power-flow and short- circuit problems. Three lecture hours per week.
Prerequisites: EENG 340 with a minimum grade of D

EENG 442. Electrical Power Distribution System in Engineering. (3 Credits)
Distribution system planning; load characteristics; distribution transformer applications; design of sub-transmission lines, substations, primary and secondary distribution systems; voltage regulation; capacitor applications; protection. Three lecture hours per week.
Prerequisites: EENG 340 with a minimum grade of D

EENG 443. Analysis of Electrical Machines. (3 Credits)
D.C. machine dynamics; D.C. motor starters and controllers; synchronous machine steady-state and transient performance; polyphase induction machine dynamics; A.C. motor starters and controllers; transformer applications; fractional horsepower A.C. motors; power electronics. Three lecture hours per week.
Prerequisites: EENG 340 with a minimum grade of D

EENG 481. Special Topics Electrical Engineering. (1-3 Credits)
May be repeated for credit.
Courses of special interest may be offered from time to time. Prerequisites will depend on the nature of the material offered and will be announced.

EENG 483. Independent Study. (1-4 Credits)
May be repeated for credit.
Topics to be determined by instructor.