

Electrical Engineering (ELEC)

Mission Statement

The rapidly changing field of electrical and computer engineering has great impact on human well-being. To meet the trust placed in our profession, students and faculty in the Electrical and Computer Engineering Department continually strive to be:

- Aware - we recognize the social and ethical dimensions of engineering.
- Engaged - we seek transformative experiences and intellectual challenges.
- Skillful - we merge knowledge with application in our professional identity.
- Articulate - we are agile communicators who effectively reach diverse audiences.
- Collaborative - we compassionately support each other to reach our full potential.
- Contemporary - we create new opportunities by designing solutions to meaningful problems.

Program Educational Objectives

Bucknell's broad, liberal education allows graduates to choose from many possible career pathways. The Electrical and Computer Engineering programs supplement this liberal education with quantitative reasoning skills and the ability to address complex, abstract problems so that in the years following graduation Bucknell alumni...

- can utilize and adapt engineering analysis and design knowledge and skills to successfully address professional challenges across a diverse spectrum of career paths.
- are respected in their chosen field due to their professionalism, ethical grounding, effective communication skills, ability to work with others, and understanding of the broader societal contexts of engineering.
- apply their problem solving skills and passion for life-long learning to their chosen endeavors.
- are actively engaged with their profession and community and continue to develop professionally, socially, and personally.

The first year requirements for the **Bachelor of Science** in electrical engineering and **Bachelor of Science** in computer engineering are identical:

Bachelor of Science in Electrical Engineering

The **Bachelor of Science** in electrical engineering requirements are:

First Year

First Semester	Credits	Second Semester	Credits
ENGR 100	1	CSCI 203	1
MATH 201	1	ELEC 120	1
PHYS 211	1	MATH 202	1
Elective	1	PHYS 212	1
	4		4

Sophomore

First Semester	Credits	Second Semester	Credits
CHEM 201	1	ELEC 226	.5
MATH 211	1	ELEC 240	1
ELEC 225	.5	ENGR 221	1
Elective (Science/Math Recommended)	1	MATH 212	1
Elective	1	Elective	1
	4.5		4.5

Junior

First Semester	Credits	Second Semester	Credits
ELEC 320	1	ELEC 301	.5
ELEC 350	1	ELEC 347	1
ENGR 240	1	ELEC 351	1
Elective	1	ELEC 390	1
		Elective	1
	4		4.5

Senior

First Semester	Credits	Second Semester	Credits
ELEC 400	.5	ELEC 420	1
ELEC 471	1	Three electives	3
ELEC 480	1		
ELEC 491	1		
Elective	1		
	4.5		4

Total Credits: 34

The 10 elective courses shown above must be distributed as follows:

- Five approved social science and humanities courses to meet the Engineering General Education requirements. These courses must satisfy the following requirements:
 1. a minimum of two courses must be in the humanities, and at least one must be an English course,
 2. a minimum of two courses must be in the social sciences; and
 3. at least one course must satisfy the global and societal perspectives requirement; and
 4. two courses must be in a single department, or at least one course must be at the 200-level or above.
- One course at the 200-level or above in the natural sciences (physics and astronomy, chemistry, or biology) or the following:

MATH 241	Discrete Structures	1
MATH 245	Linear Algebra	1
GEOL 203	Physical/Environmental Geology	1
GEOL 250	Geology for Engineers	1
GEOL 334	Geophysics	1
- At least one 400-level elective course in electrical engineering, not including ELEC 495 Advanced Topics in Engineering Mathematics and independent study courses.
- Three unrestricted elective courses in any department or program of the University. It is recommended that students intending to pursue graduate studies choose at least one of these courses:

MATH 343	Numerical Analysis	1
MATH 345	Advanced Linear Algebra	1
MATH 362	Complex Analysis	1

Three courses must fulfill the University writing requirement, which consists of one W1 course taken in the first year and two W2 courses taken at any time after the W1 course. Note that ELEC 400 Project Planning and Engineering Design and ELEC 420 Electrical Engineering Design satisfy the W2 requirement.

Faculty

Professors: Maurice F. Aburdene, John C. Bravman, R. Alan Cheville (Chair), Richard J. Kozick

Associate Professors: Peter M. Jansson, David F. Kelley, Robert M. Nickel, Michael S. Thompson, Joseph V. Tranquillo

Assistant Professors: K. Joseph Hass, Amal Kabalan, Matthew A. Watkins

Visiting Assistant Professor: Raghav Khanna

Courses

ELEC 101. Electrical Engineer Analysis. 1 Credit.

Offered Spring Semester Only; Lecture hours:3,Other:2

Introduction to concepts, voltage, current, signals, network elements, and Kirchhoff's laws. Electrical measurements, energy and information generation, storage and transmission. Introduction to logic circuits and switching theory. Not for majors in electrical engineering. Corequisite: MATH 202.

ELEC 120. Foundations of Electrical Engineering. 1 Credit.

Offered Spring Semester Only; Lecture hours:3,Other:3

Introduction to the fundamental concepts of electrical engineering. Voltage, current, signals, electrical elements and their laws. Kirchhoff's laws. Digital systems, logic design using FPGAs. Electrical measurements. Corequisite: MATH 202.

ELEC 205. Electrical Engineering Fundamentals. 1 Credit.**Offered Both Fall and Spring; Lecture hours:3,Other:2**

Electrical measurement and physical quantities, sensors, sensor dynamics, filters, computer-controlled measurements, data storage and analysis, networked measurements. Corequisite: MATH 202.

ELEC 225. Circuit Theory I. .5 Credits.**Offered Fall Semester Only; Lecture hours:2,Other:2**

DC circuits, steady-state analysis, impedance concepts, operational amplifiers, power calculations. Corequisite: MATH 211. Prerequisite: ELEC 120 or permission of the instructor.

ELEC 226. Circuit Theory II. .5 Credits.**Offered Spring Semester Only; Lecture hours:2,Other:2**

Transformers, complex power, three-phase circuits, transients, filters, Fourier series, and Laplace transform. Corequisite: MATH 212. Prerequisite: ELEC 225 or permission of the instructor.

ELEC 228. Electrical Engineering Problems. .5-1 Credits.**Offered Both Fall and Spring; Lecture hours:Varies; Repeatable**

Problems in electrical engineering theory adapted to the needs of the student. Qualified juniors or sophomores by permission, or transfer students needing to meet special requirements.

ELEC 229. Electrical Engineering Problems. .5-1 Credits.**Offered Both Fall and Spring; Lecture hours:Varies; Repeatable**

Problems in electrical engineering theory adapted to the needs of the student. Qualified juniors or sophomores by permission, or transfer students needing to meet special requirements.

ELEC 240. Digital System Design. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Other:2**

Comprehensive introduction to modern digital design techniques. Combinational and sequential logic, finite state machines, CAD tools and algorithms, and programmable logic devices. Prerequisite: ELEC 120 or permission of the instructor.

ELEC 245. Introduction to Digital Systems. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Other:3**

Analysis and design of digital systems. Boolean algebra and map simplification of logical functions. Combinational and sequential circuit designs. Laboratory experiments include design of digital systems using hardware components and computer simulation. Prerequisite: ELEC 101.

ELEC 301. Praxis of Engineering Design. .5 Credits.**Offered Spring Semester Only; Lecture hours:Varies,Other:2**

Project-oriented course that focuses on electrical and computer engineering design as distinct from analysis with the goal of developing skills in prototyping, professional communication, and test and measurement. Prerequisite: Junior standing in ELEC or permission of the instructor.

ELEC 308. Advanced Electrical Engineering Laboratory. 1 Credit.**Offered Either Fall or Spring; Lecture hours:Varies; Repeatable**

Special laboratory work for qualified seniors by permission. Prerequisite: permission of the instructor.

ELEC 309. Advanced Electrical Engineering Laboratory. 1 Credit.**Offered Either Fall or Spring; Lecture hours:Varies; Repeatable**

Special laboratory work for qualified seniors by permission. Prerequisite: permission of the instructor.

ELEC 320. Linear Systems and Signal Processing. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Other:2**

Discrete and continuous signals; differential and difference equations; state equations; transform techniques (Z, Laplace, Fourier); analog and digital filters designs. Prerequisites: ELEC 226 and MATH 212.

ELEC 347. Microcontroller System Design. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Other:2**

A modern microcontroller is used to introduce basic concepts in computer architecture, assembly language, programming, interrupts, and microcontroller interfacing. Prerequisites: ELEC 240 and CSCI 203, or permission of the instructor.

ELEC 350. Electronics I. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Other:2**

Introduction to semiconductor components and circuits. Device physics, operation, and modeling; design applications of operational amplifiers, diodes, and transistors; PN junctions; bipolar and field-effect structures; digital logic circuits. Prerequisite: ELEC 226 or permission of the instructor.

ELEC 351. Electronics II. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Other:2**

Basic amplifier circuits, differential amplifiers, frequency response, and feedback concepts. Prerequisite: ELEC 350 or permission of the instructor.

ELEC 390. Theory and Applications of Electromagnetics. 1 Credit.**Offered Spring Semester Only; Lecture hours:4**

Applications of Maxwell's equations to the solution of problems involving static electric and magnetic fields and transverse electromagnetic waves. Transmission line parameters, wave propagation, reflection from planar surfaces, boundary conditions, polarization, and electromagnetic properties of matter. Prerequisites: ELEC 226 and MATH 212.

ELEC 3NT. ELEC Non-traditional Study. .5-1 Credits.**Offered Fall, Spring, Summer; Lecture hours:Varies,Other:3**

Nontraditional study in electrical engineering. Prerequisite: permission of the instructor.

ELEC 400. Project Planning and Engineering Design. .5 Credits.**Offered Fall Semester Only; Lecture hours:3**

Introduction to design, conceptual design, design evaluation, project planning and scheduling for Electrical Engineering Senior Design Project and development of design proposal. Prerequisite: senior status or permission of the instructor.

ELEC 402. Special Topics in Electrical or Computer Engineering. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3; Repeatable**

Current topics of interest in electrical or computer engineering. This course includes a lab section. Prerequisite: permission of the instructor.

ELEC 403. Special Topics in Electrical or Computer Engineering. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4; Repeatable**

Current topics of interest in electrical or computer engineering. This course does not include a lab section. Prerequisite: permission of the instructor.

ELEC 404. ECE Honors Thesis. .5-1 Credits.**Offered Fall Semester Only; Lecture hours:Varies**

Independent work on an electrical or computer engineering thesis. Prerequisites: Permission of the instructor and Honors Council.

ELEC 411. Neural Signals and Systems. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3,Other:1**

Introduction to neural systems and signaling. Topics include neural physiology, models of action potential generation and synapse dynamics, neural networks and techniques of neural waveform analysis. Prerequisite: Permission of the instructor. Crosslisted as BMEG 441.

ELEC 420. Electrical Engineering Design. 1 Credit.**Offered Spring Semester Only; Lecture hours:Varies,Other:6**

This project-oriented course serves as a capstone for electrical engineering majors. Students work in teams to develop, implement, demonstrate, and evaluate a solution to a relevant engineering problem. Prerequisite: senior status or permission of the instructor. Crosslisted as CPEG 420.

ELEC 428. Advanced Electrical Engineering Problems. .5-1 Credits.**Offered Either Fall or Spring; Lecture hours:Varies; Repeatable**

Problems in electrical engineering theory adapted to the needs of the student. Prerequisite: permission of the instructor.

ELEC 429. Advanced Electrical Engineering Problems. .5-1 Credits.**Offered Either Fall or Spring; Lecture hours:Varies; Repeatable**

Problems in electrical engineering theory adapted to the needs of the student. Prerequisite: permission of the instructor.

ELEC 442. Digital VLSI Circuit Design. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Introduction to digital integrated circuit design, from wafer fabrication through structured design techniques. Teams conceptualize, design, simulate, layout, extract, and verify small VLSI systems using appropriate CAD tools. Prerequisites: ELEC 240 and ELEC 350 or permission of the instructor.

ELEC 443. High Performance Computer Architecture. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Topics include "good" computer architecture, RISC/CISC, pipelining, super-scalar, super-pipelining, out-of-order execution, speculative execution, virtual memory, and caches coherence. Prerequisites: ELEC 347, CSCI 206, or permission of the instructor.

ELEC 444. Advanced Digital Design. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3,Other:2**

Hardware description languages. High-level synthesis. Logic synthesis. Field-programmable gate-array architectures and applications. Prerequisites: ELEC 240, ELEC 245, or permission of the instructor.

ELEC 463. Introduction to Mechatronics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Mechatronics is a multi-discipline technical area defined as the synergistic integration of mechanical engineering with electronic and intelligent computer control in the design and manufacture of industrial products and processes. This design-directed course will cover topics such as actuators and drive systems, sensors, programmable controllers, microcontroller programming and interfacing, and automation systems integration. Crosslisted as MECH 463. Prerequisite: permission of the instructor.

ELEC 470. Communication and Information Systems. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Digital and analog communication systems, modulation techniques, noise considerations, optimum receivers. Prerequisite: ELEC 320 or permission of the instructor.

ELEC 471. Probability with Applications in Electrical Engineering. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Introduction to probability and statistics. Projects illustrate the relevance and importance of probability and statistics in electrical engineering. Probability axioms; disjoint and independent events; conditional probability; random variables; probability mass/density functions; expected value, mean, variance, and covariance; noise characterization; Gaussian random variables, least-squares estimation of parameters and random variables; electrical engineering applications. Corequisite: ELEC 320 or permission of the instructor.

ELEC 472. Digital Signal Processing. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3,Other:2**

Sampling A/D and D/A conversion; digital filters; recursive and nonrecursive designs, quantization effects, Fast Fourier Transform; spectral estimation; computer implementations; applications. Prerequisite: ELEC 320 or permission of the instructor.

ELEC 473. Digital Speech and Audio Processing. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Theory and application of digital speech and audio processing. Topics include speech and audio (MP3) coding, artificial speech synthesis, automatic speech recognition, and audio effects. Prerequisite: ELEC 320 or permission of the instructor.

ELEC 475. Computer Communication Network. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3,Other:2**

An introduction to computer networking using the seven-layer Open Systems Interconnection model. Hands-on exploration of the data link, network, transport, and application layers. Prerequisite: junior status.

ELEC 477. Wireless System Design. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3,Other:2**

Introduction to hardware aspects of wireless communication systems, including RF circuit design, transmitter and receiver architecture, antennas, and radio wave propagation. Corequisite: ELEC 390 or permission of the instructor.

ELEC 480. Electrical Control Systems. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Other:2**

System components: closed loop systems; stability from Nyquist and root locus viewpoints: performance, compensation techniques, sampled systems, Z-Transforms. Prerequisites: ELEC 320 and ELEC 350.

ELEC 491. Electrical Energy Conversion. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Other:3**

Three phase power circuits, transformer circuits, rotating machines and equivalent circuits, power electronic switches, machine dynamics, motor generator control. Corequisite: ELEC 390. Prerequisite: ELEC 350 or permission of the instructor.

ELEC 494. Renewable Energy Systems. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Engineering analysis of photovoltaic, wind, and other renewable energy systems. Modeling of systems, resources, and performance with an emphasis on grid-tied photovoltaic system optimization. Open to juniors and seniors in engineering.

ELEC 495. Advanced Topics in Engineering Mathematics. 1 Credit.**Offered Fall Semester Only; Lecture hours:4**

Linear algebra and analytical computation techniques for solving ordinary and partial differential equations relevant to engineering applications. Prerequisite: permission of the instructor. Crosslisted as CENG 495, CHEG 495, MECH 495.