

# ELECTRICAL ENGINEERING (ELEC)

## Faculty

**Professors:** Maurice F. Aburdene, John C. Bravman (President), 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:** Philip Asare, Amal Kabalan

**Visiting Associate Professor:** Meriel Huggard

**Visiting Assistant Professor:** Salem Ali A. Elsaiah

## 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 lifelong 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 ECEG 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 ECEG 226	.5
ECEG 225	.5	ECEG 240	1
MATH 211		1 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
ECEG 320	1	ECEG 301	.5
ECEG 350	1	ECEG 347	1
ENGR 240	1	ECEG 351	1
Elective	1	ECEG 390	1
		Elective	1
		4	4.5

**Senior**

First Semester	Credits	Second Semester	Credits
ECEG 400	.5	ECEG 401	1
ECEG 471	1	ECEG 480	1
ECEG 491	1	Two electives	2
Two electives	2		
		4.5	4

Total Credits: 34

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

- Five courses that will fulfill the General Education requirement, selected from any of the following: social science courses, arts and humanities courses, university courses, residential college courses, or foundation seminars. These five courses must include one course in arts and humanities and one course in social sciences.
- 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 ECEG 495 Advanced Topics in Engineering Mathematics and independent study courses.
- Three unrestricted elective courses in any department or program of the University.

Three courses in each student's program must also fulfill the University writing requirement, and one course in each student's program must also fulfill the college global perspectives requirement. Note that ECEG 400 Project Planning and Engineering Design and ECEG 401 Electrical and Computer Engineering Design satisfy the W2 requirement.

At graduation a Bucknell electrical or computer engineer:

- 1) Knows the foundational principles of engineering and the context needed to use them by demonstrating...
  - an ability to apply knowledge of mathematics, science, and engineering
  - the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
  - a knowledge of contemporary issues
- 2) Possesses the skills and abilities needed to practice electrical or computer engineering by demonstrating...
  - an ability to design and conduct experiments, as well as to analyze and interpret data.
  - an ability to identify, formulate, and solve engineering problems

*that, through the engineering design process, leads to*

- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
  - an ability to communicate effectively
  - an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- 3) Possesses the professionalism and attitudes needed to be an electrical or computer engineer by demonstrating...
    - an ability to function on multi-disciplinary teams

- an understanding of professional and ethical responsibility
- a recognition of the need for, and an ability to engage in life-long learning

## Courses

### **ECEG 101. Electrical and Computer Engineering Analysis. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Lab: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 and computer engineering. Corequisite: MATH 202.

### **ECEG 120. Introduction to Electrical and Computer Engineering. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Lab:2**

Introduction to the fundamental concepts of electrical and computer engineering. Voltage, current, signals, electrical elements and their laws. Kirchhoff's laws and basic circuit analysis. Digital systems. Electrical measurements. Computational tools and circuit modeling software. Corequisite: MATH 202.

### **ECEG 205. Electrical and Computer Engineering Fundamentals. 1 Credit.**

**Offered Both Fall and Spring; Lecture hours:3,Lab:2**

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

### **ECEG 225. Circuit Theory I. .5 Credits.**

**Offered Fall Semester Only; Lecture hours:2,Lab:2**

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

### **ECEG 226. Circuit Theory II. .5 Credits.**

**Offered Spring Semester Only; Lecture hours:2,Lab:2**

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

### **ECEG 240. Digital System Design. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Lab:2**

Comprehensive introduction to modern digital design techniques. Combinational and sequential logic, finite state machines, CAD tools and algorithms, and programmable logic devices. Prerequisite: ECEG 120, or CSCI 206, or permission of the instructor.

### **ECEG 245. Introduction to Digital Systems. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Lab:3**

Comprehensive introduction to modern digital design techniques. Combinational and sequential logic, finite state machines, CAD tools and algorithms, and programmable logic devices. Prerequisite: ECEG 101.

### **ECEG 2NT. Electrical and Computer Engineering Non-traditional Study. .25-4 Credits.**

**Offered Fall, Spring, Summer; Lecture hours:Varies**

Non-traditional study in electrical and computer engineering. Prerequisite: permission of the instructor.

### **ECEG 301. Praxis of Engineering Design. .5 Credits.**

**Offered Spring Semester Only; Lecture hours:Varies,Lab: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 ECE or permission of the instructor.

### **ECEG 308. Independent Study. .5-1 Credits.**

**Offered Either Fall or Spring; Lecture hours:Varies; Repeatable**

Independent study for qualified first-years, sophomores, and juniors. Prerequisite: permission of the instructor.

### **ECEG 320. Linear Systems and Signal Processing. 1 Credit.**

**Offered Fall Semester Only; Lecture hours:3,Lab:2**

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

### **ECEG 347. Embedded and Cyber-Physical Systems. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Lab:2**

Concepts, principles, tools, and techniques for the design, analysis, and implementation of embedded and cyber-physical systems. Integrative course that draws on topics from across the electrical and computer engineering curriculum. Prerequisites: ECEG 240 and CSCI 203, or permission of the instructor.

### **ECEG 350. Electronics I. 1 Credit.**

**Offered Fall Semester Only; Lecture hours:3,Lab: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: ECEG 226 or permission of the instructor.

**ECEG 351. Electronics II. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Lab:2**

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

**ECEG 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: ECEG 226 and MATH 212.

**ECEG 3NT. Electrical and Computer Engineering Non-traditional Study. .25-4 Credits.**

**Offered Fall, Spring, Summer; Lecture hours:Varies,Other:3**

Non-traditional study in electrical and computer engineering. Prerequisite: permission of the instructor.

**ECEG 400. Project Planning and Engineering Design. .5 Credits.**

**Offered Fall Semester Only; Lecture hours:3,Lab:2**

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

**ECEG 401. Electrical and Computer Engineering Senior Design. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:2,Other:2**

This project-oriented course is the continuation of capstone design for electrical and computer engineering majors. Students work in teams to develop, implement, and evaluate an effective solution to an open-ended problem. Prerequisite: ECEG 400 or permission of the instructor.

**ECEG 402. Special Topics in Electrical or Computer Engineering. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3,Lab:2; Repeatable**

Current topics of interest in electrical or computer engineering. This course includes a lab section.

**ECEG 403. Special Topics in Electrical and Computer Engineering. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:4; Repeatable**

Current topics of interest in electrical and computer engineering. This course does not include a lab section.

**ECEG 404. Electrical and Computer Engineering Honors Thesis. .5 Credits.**

**Offered Fall Semester Only; Lecture hours:1.5**

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

**ECEG 408. Advanced Independent Study. .5-1 Credits.**

**Offered Either Fall or Spring; Lecture hours:Varies; Repeatable**

Advanced independent study for qualified seniors. Prerequisite: Permission of instructor.

**ECEG 409. Engineering: A Humanist Enterprise. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3**

This course explores engineering as a human activity geared towards meeting human goals and undertaken by humans. The course explores how multiple disciplinary perspectives are required to undertake good engineering, and how our nature as humans affects engineering activities to help students transcend disciplinary boundaries. Crosslisted as UNIV 350.

**ECEG 411. Neural Signals and Systems. 1 Credit.**

**Offered Occasionally; Lecture hours:3,Recitation: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 and ECEG 611.

**ECEG 430. Mobile Computing. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:4**

Mobile computing ecosystem including apps, devices, wireless networks, and back-end systems. Includes at least one major project; the specific course content will vary based on projects, student interest, and current technology trends. This course typically includes a considerable amount of software development. Prerequisites: CSCI 206 or permission of instructor.

**ECEG 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: ECEG 240 and ECEG 350 or permission of the instructor.

**ECEG 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: ECEG 347, CSCI 206, or permission of the instructor.

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

Design of multi-part digital systems using contemporary digital components centered around a system-on-chip with a microprocessor and FPGA. Hardware description languages, specialized FPGA elements, peripheral interfacing and protocols, high-level synthesis. Prerequisites: ECEG 240, ECEG 245, or permission of the instructor. Crosslisted as ECEG 644.

**ECEG 445. Solid State Optoelectronic Devices. 1 Credit.****Offered Either Fall or Spring; Lecture hours:2,Other:2**

Basic principles required to understand the operation of solid-state devices. Semiconductor device equations developed from fundamental concepts. P-N junction theory developed and applied to the analysis of devices such as solar cells and light emitting diodes. Emphasis on device physics rather than circuit applications.

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

This multidisciplinary course is the synergistic integration of mechanical engineering with electronic and computer engineering. This course will study actuators, drive systems, sensors, controllers, micro- controllers programming and interfacing, and automation systems integration. Prerequisite: permission of the instructor. Crosslisted as MECH 463 and MECH 663 and ECEG 663.

**ECEG 470. Communication and Information Systems. 1 Credit.****Lecture hours:3**

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

**ECEG 471. Applications of Probability in Electrical and Computer Engineering. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Lab:2**

Probability theory, random variables, probability mass/density functions, expected value, Gaussian distribution, detection, estimation, applications in electrical and computer engineering. Prerequisite: ECEG 320 or permission of the instructor.

**ECEG 472. Digital Signal Processing. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Lab: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: ECEG 320 or permission of the instructor.

**ECEG 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: ECEG 320 or permission of the instructor.

**ECEG 475. Computer Communication Networking. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3**

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.

**ECEG 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: ECEG 390 or permission of the instructor.

**ECEG 480. Electrical Control Systems. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Lab:2**

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

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

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

**ECEG 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.

**ECEG 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. Crosslisted as CEEG 495 and CHEG 495 and MECH 495 and ENGR 695. Prerequisite: permission of the instructor.