

# ELECTRICAL ENGINEERING

Department Website ([https://sc.edu/study/colleges\\_schools/engineering\\_and\\_computing/study/electrical\\_engineering/](https://sc.edu/study/colleges_schools/engineering_and_computing/study/electrical_engineering/))

Mohammad Ali, *Chair*

Electrical engineers create electronic devices, circuits, and systems that create, process, or distribute information and energy. Graduates of this program are prepared for a wide range of professional practice through a combination of core and career plan courses. The first two years of study establish a technical foundation in math, science, and engineering principles and a responsible social foundation in the liberal arts. The last two years of study focus each student's interest into a specialty area appropriate to their own career objectives. The department's web site describes a wide range of sample career plans, ranging from renewable energy systems to 5G communication networks. The department is well-known for its outstanding hands-on laboratory sequence and for encouraging highly talented and motivated undergraduate students to participate in its many research programs. The rapid pace of developments in electrical engineering requires that graduates make strong commitments to lifelong learning, and it ensures that graduates will be presented with many exciting and diverse opportunities throughout their professional careers.

## Accelerated BSE/Graduate Program

Qualifying Electrical Engineering majors can enroll in the Accelerated bachelors/graduate degree program and then earn graduate credit for up to 12 credit hours of courses that can also be applied to their baccalaureate program. These students can typically complete a graduate degree (ME, MS, or PhD) one to two semesters faster than would otherwise be possible. Requirements for this program appear on the Molinaroli College of Engineering and Computing pages.

## Programs

- Electrical Engineering Minor (<https://academicbulletins.sc.edu/undergraduate/engineering-computing/electrical-engineering/electrical-engineering-minor/>)
- Electrical Engineering, B.S.E. (<https://academicbulletins.sc.edu/undergraduate/engineering-computing/electrical-engineering/electrical-engineering-bse/>)

## Courses

### ELCT 101 - Electrical and Electronics Engineering (1 Credit)

Introductions to: the profession of electrical engineering; the wide range of sub-disciplines that make electrical engineering so valuable in improving the human condition; the role of electrical engineers in society; and the role of electrical engineering students in the university.

### ELCT 102 - Electrical Science (3 Credits)

Fundamentals of electrical and electronic components. Basic network laws. Mathematical and computer tools for network analysis.

**Prerequisite or Corequisite:** MATH 141

### ELCT 201 - Introductory Electrical Engineering Laboratory (3 Credits)

Laboratory procedures, instrumentation and measurements, report writing, computer use in system design, testing, and troubleshooting. Integrative project-based learning environment including passive, active, electronic and electromechanical systems.

**Prerequisites:** C or better in ENGL 102 and C or better in CSCE 211.

**Prerequisite or Corequisite:** ELCT 222.

### ELCT 220 - Electrical Engineering for Non-Majors (3 Credits)

Fundamentals of electrical engineering for mechanical, chemical, or other engineering disciplines, including electric circuits, measurements, data acquisition, sensors, motors, and controllers.

**Prerequisites:** MATH 142.

### ELCT 221 - Circuits (3 Credits)

Analysis of linear ac circuits using complex variables. Nodal and mesh analysis, Thevenin and Norton transformations, linearity, superposition, use of math solvers, circuit simulators, and computer-interfaced instrumentation.

**Prerequisites:** C or better in MATH 142; C or better in either ELCT 102 or AESP 265 or D or better in ELCT 220.

### ELCT 222 - Signals and Systems (3 Credits)

Analysis of continuous-time signals and systems in time and frequency domains, Fourier series and transforms, Laplace transforms; introduction to discrete-time signals.

**Prerequisites:** C or better in ELCT 221 and in MATH 242.

### ELCT 301 - Electronics Laboratory (3 Credits)

Design and implementation of analog and digital electronic circuits, with emphasis on developing deep individual understanding of curriculum-spanning concepts.

**Prerequisites:** D or better in ELCT 201.

**Prerequisite or Corequisite:** D or better in ELCT 371.

### ELCT 302 - Real Time Systems Laboratory (3 Credits)

Team-oriented application of sensing, measurement, and real time embedded digital control for autonomous vehicular systems. Requirements analysis, system modeling, software/hardware integration, report writing, development of teaming skills.

**Prerequisites:** D or better in ELCT 301.

**Prerequisite or Corequisite:** D or better in ELCT 331.

### ELCT 321 - Digital Signal Processing (3 Credits)

An introduction to analysis, design and applications of discrete time systems; z- and discrete Fourier transforms; frequency and impulse responses, FIR and IIR filters.

**Prerequisites:** C or better in ELCT 222.

### ELCT 331 - Control Systems (3 Credits)

Fundamentals of control systems. Analysis and design of control systems using physical system models. State variables, steady-state error, time- and frequency-responses, control system stability. Root locus analysis and controller design – PI, PD, PID, lead-lag compensator. Nyquist stability criterion.

**Prerequisites:** C or better in ELCT 222.

**ELCT 350 - Computer Modeling of Electrical Systems (3 Credits)**

Formulation of physics-based dynamic models of electrical or electromechanical systems. Solving dynamic equations of electrical systems in discrete time. Use of object oriented programming language (e.g., C++) and computer tools (e.g, MATLAB, virtual test bed) for solving dynamic equations of electrical systems.

**Prerequisites:** C or better in ELCT 222, C or better in CSCE 145.

**ELCT 361 - Electromagnetics (3 Credits)**

Basic concepts of electric and magnetic fields, including electrostatics, magnetostatics, and quasi-statics with computer applications.

**Prerequisites:** PHYS 212 and MATH 241.

**ELCT 363 - Introduction to Microelectronics (3 Credits)**

Properties and characteristics of semiconductor materials, p-n and semiconductor-metal junctions. Basic properties, characteristics and operation of diodes and transistors.

**Prerequisites:** C or better in CHEM 111, PHYS 212.

**Prerequisite or Corequisite:** C or better in MATH 241.

**ELCT 371 - Electronics (3 Credits)**

Introduction to design and analysis of electronic circuits and systems. Applications of amplifiers, op-amps, diodes, bipolar and field-effect transistors in analog and digital circuits.

**Prerequisites:** C or better in ELCT 222.

**ELCT 391 - Biometric Measurements in Healthcare and Wearables (3 Credits)**

Fundamentals of non-invasive probes for biometrics. Principles of ultrasound for echocardiography, optoelectronics for photoplethysmography, and electrochemistry for electrocardiography and electroencephalography. Introduction to amplification methods for biometric probe readout electronics. Studies of engineering tradeoffs between signal level versus adverse effects. Measurement basics of signals.

**Prerequisites:** D or better in MATH 141 or MATH 122; D or better in PHYS 201 or PHYS 211.

**ELCT 403 - Capstone Design Project I (3 Credits)**

Planning, preliminary design, and prototyping. Analysis and specification of system and subsystem requirements, measures of performance, analysis of alternatives, effective team work. Project management and scheduling. Prototype implementation and characterization. This course should be taken during student's penultimate semester.

**Prerequisites:** D or better in ELCT 302.

**Graduation with Leadership Distinction:** GLD: Professional and Civic Engagement Internships, GLD: Research

**ELCT 404 - Capstone Design Project II (3 Credits)**

Continuation of Capstone Design Project I. Final design and implementation including design iteration, design for reliability, system integration and characterization, business case development.

**Prerequisites:** D or better in ELCT 403.

**Graduation with Leadership Distinction:** GLD: Professional and Civic Engagement Internships, GLD: Research

**Experiential Learning:** Experiential Learning Opportunity

**ELCT 430 - Industrial Controls (3 Credits)**

The embedded electronics and software used in data acquisition, and process and instrument control in an industrial or manufacturing environment.

**Prerequisites:** ELCT 331.

**ELCT 432 - Fundamentals of Communication Systems (3 Credits)**

Introduction to communication systems, sampling theorem, modulation theory, multiplexing, phase-lock loops, and related topics.

**Prerequisite or Corequisite:** ELCT 321 and STAT 509.

**ELCT 451 - Power Systems Design and Analysis (3 Credits)**

Electric power systems including transformer fundamentals, per-unit analysis, transmission and distribution line design, and power flow analysis.

**Prerequisites:** C or better in ELCT 220 or ELCT 221.

**ELCT 499 - Special Problems (1-3 Credits)**

Individual investigation or studies of special topics. A maximum of 3 credits total may be applied toward a degree. Advanced approval of project proposal by instructor and department advisor.

**Graduation with Leadership Distinction:** GLD: Professional and Civic Engagement Internships, GLD: Research

**ELCT 510 - Photovoltaic Materials and Devices (3 Credits)**

Fundamentals of photovoltaic solar cell technologies. Design and operation of solar cells, including efficiency analysis and cost benefit. Applications to green and sustainable energy systems.

**Prerequisites:** C or better in ELCT 363.

**ELCT 521 - Introduction to Microwave Engineering (3 Credits)**

Introduction to plane electromagnetic wave propagation, reflection, transmission, antennas and antenna arrays, wireless link margin; noise, noise figure, noise temperature; switches and phase shifters; microwave modeling.

**Prerequisites:** D or better in ELCT 361 or PHYS 504.

**ELCT 531 - Digital Control Systems (3 Credits)**

Analysis and design of discrete-time control systems, implementation of control systems using digital electronic systems. Applications to electrical systems.

**Prerequisites:** ELCT 331.

**ELCT 533 - System Health Management (3 Credits)**

Sensing, data acquisition, and data processing for evaluation of performance and system health. Integration and implementation of health management systems.

**Prerequisites:** ELCT 321 or equivalent.

**ELCT 541 - Sensors for Biomedicine (3 Credits)**

Operating principles and design of bioelectric sensors and sensor systems for medical applications.

**Prerequisites:** C or better in ELCT 361, ELCT 363 and ELCT 371.

**ELCT 553 - Electromechanical Energy Conversion (3 Credits)**

Analysis and design of electromechanical energy conversion systems, including electrical machines and electronic drives.

**Prerequisites:** D or better in ELCT 331, ELCT 361 and ELCT 451.

**ELCT 554 - Integration of Photovoltaics in Modern Power Systems (3 Credits)**

Analysis and design of power systems in presence of photovoltaic generation with focus on protection systems, control, power quality.

**Prerequisites:** ELCT 551.

**ELCT 559 - Special Topics in Distributed Energy Resources for Electric Energy Systems (3 Credits)**

Special topics in distributed energy resources for modern electrical energy systems. Course content varies and will be announced in the schedule of classes by title. May be repeated as topics vary.

**Prerequisite or Corequisite:** D or better in ELCT 451.

**ELCT 562 - Wireless Communications (3 Credits)**

Fourier techniques and stochastic processes review, multiple access & cellular techniques, signal space representations for signals and noise, baseband modulations and optimal receivers in additive white Gaussian noise, bandpass and higher-order modulations, mobile & wireless propagation channel characteristics, effects of bandlimiting & distortion mitigation, diversity techniques.

**Prerequisites:** ELCT 332, ELCT 361.

**ELCT 563 - Semiconductor Devices for Power, Communications and Lighting (3 Credits)**

Operational principles and characteristics of electronic and optoelectronic semiconductor devices including MOSFETs and high electron mobility transistors (HEMTs) for power electronics, electric cars and high-speed communications, light emitting diodes and lasers for solid state lighting, displays and optical communication, solar cells for green power generation.

**Prerequisites:** D or better in ELCT 363.

**ELCT 564 - RF Circuit Design for Wireless Communications (3 Credits)**

RF design fundamentals, lumped elements, transmission line theory, transmission lines and waveguides, S-parameters, impedance matching, microwave resonators.

**Prerequisites:** ELCT 361.

**ELCT 572 - Power Electronics (3 Credits)**

Basic analysis and design of solid-state power electronic devices and circuitry.

**Prerequisites:** D or better in ELCT 371.

**Prerequisite or Corequisite:** D or better in ELCT 331.

**ELCT 574 - Semiconductor Materials and Device Characterization (3 Credits)**

Semiconductor material and device characterization; resistivity, carrier and doping density, contact resistance, Schottky barriers, series resistance, defects, trapped charges, and carrier lifetime.

**Prerequisites:** ELCT 363 or equivalent.

**ELCT 582 - Semiconductor Laboratory (3 Credits)**

Prerequisite: ELCT 363.