

# ELECTRICAL AND COMPUTER ENGINEERING

## THE GEORGE R. BROWN SCHOOL OF ENGINEERING

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### **PROFESSOR IN THE PRACTICE**

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The Department of Electrical and Computer Engineering (ECE) strives to provide high-quality degree programs that emphasize fundamental principles, respond to the changing demands and opportunities of new technology, challenge the exceptional abilities of Rice students, and prepare students for roles of leadership in their chosen careers. Undergraduate and graduate programs in ECE offer concentrations in areas that include system and control theory; communications; quantum electronics and lasers; computer systems; and electronic materials, devices, and circuits. The latest information on the department's faculty, research areas, and degree programs and requirements can be found on the ECE website: [www.ece.rice.edu/](http://www.ece.rice.edu/).

## **UNDERGRADUATE DEGREE PROGRAMS**

The department offers 2 undergraduate degrees, the bachelor of arts (BA) and the bachelor of science in electrical engineering (BSEE). The BA degree provides a basic foundation in electrical and computer engineering that the student can build on to construct a custom program. Because of its flexibility and large number of free electives, the BA can be easily combined with courses from other departments to create an interdisciplinary program. This may be

particularly appropriate for students planning further study in law, business, or medicine.

The BSEE degree is the usual degree taken by those students planning a career in engineering practice. It is accredited by the Accreditation Board for Engineering and Technology (ABET) and can reduce the time required to become a licensed professional engineer. The program for the BSEE requires more hours and greater depth than the BA degree but still provides considerable flexibility.

Both degrees are organized around a core of required courses and a selection of elective courses from 4 specialization areas. Each student's program must contain a depth sequence in 1 area and courses from at least 2 areas to provide breadth. The specialization electives provide a flexibility that can be used to create a focus that crosses traditional areas. Because of the number of options, students should consult early with department advisors to plan a program that meets their needs.

**BSEE Degree Requirements**—See Graduation Requirements (pages 14–15) for general university requirements. A BSEE program must have a total of at least 134 semester hours and include the following courses. A course can satisfy only 1 program requirement, except for design. Students who place out of required courses without transcript credit must substitute other approved courses in the same area. Current degree requirements and planning sheets may be found on the ECE website.

### **Mathematics and Science Courses**

MATH 101 *Single Variable Calculus I*

MATH 102 *Single Variable Calculus II*

MATH 212 *Multivariable Calculus*

ELEC 331 *Applied Probability*

CAAM 335 *Matrix Analysis* or

MATH 355 *Linear Algebra*

PHYS 101 *Mechanics*

PHYS 102 *Electricity and Magnetism*

ELEC 261 *Electronic Materials and Quantum Devices*

CHEM 121 *General Chemistry*

Additional approved mathematics and science courses to bring the total to 32 hours.

### **ECE Core Courses**

ELEC 220 *Fundamentals of Computer Engineering*

ELEC 241 *Fundamentals of Electrical Engineering I*

ELEC 242 *Fundamentals of Electrical Engineering II*

ELEC 301 *Introduction to Signals*

ELEC 305 *Introduction to Physical Electronics*

ELEC 326 *Digital Logic Systems*

**Computation Course:** One from

COMP 201 *Principles of Computing and Programming*

CAAM 210 *Introduction to Engineering Computation*

### **Design Courses**

ELEC 391 *Professional Issues in Electrical Engineering*

ELEC 493 *Senior Design Seminar*

ELEC 494 *Senior Design Laboratory*

One from:

ELEC 424 *Mobile and Imbedded System Design and Applications*

ELEC 432 *Digital Radio System Design*

ELEC 464 *Photonic Sensor System Design*

ELEC 491 *Independent Design Project*

### **Specialization Area Courses**

Upper-level ECE courses are organized into 4 specialization areas: computer engineering, systems, electronic circuits and devices, and quantum electronics. The computer engineering area provides a broad background in computer systems engineering, including computer architecture, digital hardware

engineering, software engineering, and computer systems performance analysis. The systems area involves the study of processing and communicating signals and information through systems or devices, control theory, signal and image processing, and communications. The electronic circuits and devices area covers the design of analog circuits, electromechanical devices, and the design and manufacturing of semiconductor devices. The quantum electronics area encompasses studies of electronic materials, including nanomaterials, semiconductor and optoelectronic devices, lasers and their applications, and photonics.

The BSEE program must include seven courses total from at least 2 areas, including at least 4 courses in 1 area. Graduate courses and equivalent courses from other departments may be used to satisfy area requirements with permission; consult the ECE website for the latest list of specialization area courses.

### ***Design Requirement***

All BSEE degree candidates must complete a design sequence of 4 courses taken during the junior and senior years. Two required seminars, ELEC 391 (spring, junior year) and ELEC 493 (fall, senior year), provide instruction in professional engineering topics, including ethics, design methodology, project planning, technical presentations, documentation, etc. In the fall semester of the senior year, students can choose any one of the approved design elective courses (see the ECE website for the current list). These courses, except for ELEC 491, provide technical instruction in a subject area and the development of a design project concept in that area. In the spring semester, the required ELEC 494 provides laboratory time in which to actually realize the project. ELEC 491, in conjunction with ELEC 494, provides 2 full semesters for more elaborate projects, including participation in design competitions sponsored by engineering societies. ELEC 491–494 independent design projects require advance approval by the ECE Undergraduate Curriculum Committee.

### ***Unrestricted Electives***

Additional courses to provide the BSEE minimum requirement of at least 134 semester hours.

**BA Degree Requirements**—See Graduation Requirements (pages 14–15) for general university requirements. A BA program must have a total of at least 120 semester hours and include the following courses. A course can satisfy only 1 program requirement, except for laboratory. Students who place out of required courses without transcript credit must substitute other approved courses in the same area. Current degree requirements and planning sheets may be found on the ECE website.

### ***Mathematics and Science Courses***

MATH 101 *Single Variable Calculus I*

MATH 102 *Single Variable Calculus II*

MATH 212 *Multivariable Calculus* or

CAAM 335 *Matrix Analysis*

CAAM 335 *Matrix Analysis* or

MATH 355 *Linear Algebra*

One from: ELEC 331 *Applied Probability*, MATH

355 *Linear Algebra*, MATH 381 *Introduction to*

*Partial Differential Equations* or

CAAM 335 *Matrix Analysis*

PHYS 101 *Mechanics*

PHYS 102 *Electricity and Magnetism*

ELEC 261 *Electronic Materials and Quantum Devices* or CHEM 121 *General Chemistry*

### ***ECE Core Courses***

ELEC 220 *Fundamentals of Computer Engineering*

ELEC 241 *Fundamentals of Electrical Engineering I*

ELEC 242 *Fundamentals of Electrical Engineering II*

ELEC 305 *Introduction to Physical Electronics*

ELEC 326 *Digital Logic Systems*

**Computation Course:** 1 from

CAAM 210 *Introduction to Engineering Computation*

COMP 201 *Principles of Computing and Programming*

**Laboratory:** 1 from

ELEC 201 *Introduction to Engineering Design*

ELEC 327 *Implementation of Digital Systems*

ELEC 342 *Electronic Circuits*

ELEC 433 *Architectures for Wireless Communications*

ELEC 434 *Digital Signal Processing Laboratory*

ELEC 442 *Advanced Electronic Circuits*

ELEC 443 *Power Electronic Circuits*

ELEC 444 *Electromagnetic Interference/Compatibility*

ELEC 445 *Wireless Electronics*

ELEC 465 *Physical Electronics Practicum*

ELEC 494 *Senior Design Seminar*

### **Specialization Area Courses**

Upper-level ECE courses are organized into 4 specialization areas, as described above in the BSEE degree requirements. The BA program must include 4 courses total from at least 2 areas, including at least 2 courses in 1 area. Each course must be at least 3 semester hours. Graduate courses and equivalent courses from other departments may be used to satisfy area requirements with permission; consult the ECE website for the latest list of specialization area courses.

### **Unrestricted Electives**

Additional courses to provide the BA minimum requirement of at least 120 semester hours.

## **GRADUATE DEGREE PROGRAMS**

The ECE department offers two graduate degree programs. The master of electrical engineering (MEE) degree is a course-based program designed to increase a student's mastery of advanced subjects; no thesis is required. The MEE prepares a student to succeed and advance rapidly in today's competitive technical marketplace. A joint MBA/MEE degree is offered in conjunction with the Jesse H. Jones Graduate School of Management. The doctor of philosophy (PhD) program prepares students for a research career in academia or industry. The PhD program consists of formal courses and original research conducted under the guidance of a faculty advisor, leading to a dissertation. Students in the PhD program complete a master of science (MS) degree as part of their program; the ECE department does not admit students for a terminal MS degree.

Information on admission to graduate programs is available from the ECE Graduate Committee and on the ECE website. See the section Information for Graduate Students (page 55) for the general requirements of graduate degrees at Rice. Students must achieve at least a B (3.0) average in the courses counted toward a graduate degree. In addition, no course in which the student earned a grade lower than a C may count toward a graduate degree.

**MEE Degree Requirements**—Students must prepare a MEE degree plan and have it approved by the ECE Graduate Committee. The plan must include at least 30 semester hours of courses, all at the 300 level or above. The program should include a major area of specialization (18 semester hours), a minor area (6 semester hours), plus free electives. At least 7 of the major and minor area courses must be at the 400 level or above, and at least 4 must be at the 500 level or above. ELEC 590 or ELEC 599 may not count as major area courses; no more than 3 semester hours can be transfer credit from another university, and

at most 1 1-hour seminar course may be included in the plan. A MEE degree planning form and current requirements may be found on the ECE website.

**PhD Degree Requirements**—Students are admitted to the PhD program only in the fall semester. ECE PhD students move through the program in stages, starting as 1st-year student, advancing to MS candidate, PhD-qualified student, and PhD candidate; each advancement requires the approval of the ECE graduate committee. Students entering with previous graduate work may follow a hybrid program developed in consultation with the faculty and the graduate committee. The 1st academic year concentrates on foundation coursework and developing a research area. Each student must successfully complete a project, ELEC 599, in his or her chosen area of research in lieu of an oral or written qualifying exam. In addition to enabling the faculty to evaluate the student's research potential, the project encourages timely completion of the MS degree. The student must complete a master's thesis and successfully defend it in an oral examination. Students who already have acquired a master's degree elsewhere still are required to complete a 1st-year ELEC 599 project.

Completion of the MS degree, satisfactory performance in coursework, and a recommendation from the prospective PhD advisor is required for advancement to PhD candidacy. A candidate for the PhD degree must demonstrate independent, original research in electrical and computer engineering. After successfully presenting a PhD research proposal and completion of all coursework, a student is eligible for PhD candidacy. The student then engages in full-time research, culminating in the completion and public defense of the PhD dissertation. Details of the PhD program requirements, the phases of study, and a timetable may be found on the ECE website.

**See ELEC in the Courses of Instruction section for course descriptions.**