Electrical and Computer Engineering

The George R. Brown School of Engineering

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Lecturers
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Degrees Offered: B.A., B.S.E.E., M.E.E., M.S., Ph.D.

The electrical and computer engineering department strives to provide high quality degree programs that emphasize fundamental principles, respond to the changing demands and opportunities of technology, challenge the exceptional abilities of Rice students, and prepare these students for roles of leadership in their chosen careers.

In support of this goal, the electrical and computer engineering department's objectives are to provide its undergraduate students with:

- A solid foundation in the fundamentals of electrical and computer engineering, mathematics, and science, enabling them to adapt easily to technological developments that will occur during their careers
- An in-depth exposure to one area of electrical and computer engineering, emphasizing its relationship to the basic framework of the discipline and to other appropriate topics outside that framework

- Courses and projects that actively involve them in their own education and enhance their ability to formulate and solve real-world design and research problems
- A broad education outside of engineering and science that emphasizes the role of electrical and computer engineering in society and builds the leadership skills necessary to deal with the increasing impact of technology

Graduate and undergraduate programs in electrical and computer engineering offer concentrations in areas that include system and control theory, bioengineering, communications, quantum electronics and lasers, computer systems, and electronic materials, devices, and circuits. Bioengineering is primarily a graduate program, although undergraduates may take introductory courses in this field as electives or as part of their specialization area courses.

Undergraduate Program. The department offers two undergraduate degrees, the Bachelor of Arts (B.A.) and the Bachelor of Science in Electrical Engineering (B.S.E.E.). The B.A. program is highly flexible, permitting a student to tailor the program to his or her interests, be they broad or highly focused. The B.S.E.E. degree is approved by the Accreditation Board for Engineering and Technology (ABET); requires more scientific and professional courses, for a total of at least 134 semester hours; and has fewer electives. Outstanding students interested in careers in research and teaching may enter graduate school after either bachelor degree. Both degrees are organized around a core of required courses and a selection of elective courses from five specialization areas. Each student's program must contain a depth sequence in one area and courses from at least two areas to provide breadth. The specialization electives provide a flexibility that can be used to create a focus, such as optical communications, that crosses traditional areas. Because of the number of options, students should consult early with departmental advisers to plan a program that meets their needs.

The B.A. degree provides a basic foundation in electrical and computer engineering that the student can build upon to construct a custom program. Because of its flexibility and large number of free electives, the B.A. can be combined easily with another major to create an interdisciplinary program. This may be particularly appropriate for students planning further study in law, business, or medicine.

The B.S.E.E. is the usual degree taken by those students planning a career of engineering practice. It is accredited by ABET and can reduce the time required to become a licensed professional engineer. Accreditation and professional licensing are important for some careers, and many states require licensure for those providing engineering services directly to the public, for example, as a consultant. The program for the B.S.E.E. degree requires greater depth than the B.A. degree but still provides considerable flexibility. Students who place out of required courses but who do not have credit must substitute other approved courses *in the same area.*

The requirements for the two degrees are grouped into four categories, listed below. The specific courses required for each degree are listed in the section for that degree.

Basic Mathematics and Science Courses
MATH 101 *Single Variable Calculus I*
MATH 102 *Single Variable Calculus II*
CAAM 335 *Matrix Analysis* or MATH 355 *Linear Algebra*
MATH 212 *Multivariable Calculus*
PHYS 101 *Mechanics*
PHYS 102 *Electricity and Magnetism*
CHEM 121 *General Chemistry*
PHYS 201 W*aves and Optics*

Core Courses
ELEC 241 *Fundamentals of Electrical Engineering I*
ELEC 242 *Fundamentals of Electrical Engineering II*
ELEC 301 *Introduction to Signals* (or COMP 212 *Intermediate Programming)*
ELEC 305 *Introduction to Physical Electronics*

Core Courses (cont.)

ELEC 320 *Introduction to Computer Organization*
ELEC 326 *Digital Logic Design*
ELEC 391 *Professional Issues in Electrical Engineering*
ELEC 331 *Applied Probability*

Restricted Electives

Computation

CAAM 210 *Introduction to Engineering Computation*
CAAM 211 *Introduction to Engineering Computation*
COMP 210 *Introduction to Principles of Scientific Computation* (COMP 210 is a prerequisite for many other computer courses.)

Laboratory

ELEC 201 *Introduction to Engineering Design*
ELEC 303 *Systems Laboratory*
ELEC 327 *Digital Logic Design Laboratory*
ELEC 423 *VLSI Design II*
ELEC 433 *Communications Systems Lab*
ELEC 465 *Physical Electronics Lab*
ELEC 490 *Electrical Engineering Projects*

Specialization Areas. The following groups of courses focus on specific areas within electrical and computer engineering. The systems area involves the study of processing and communicating signals and information through systems of devices, control and robotics, signal and image processing, and communications. The computer engineering area provides a broad background in computer systems engineering, including computer architecture, hardware engineering, software engineering, and computer systems performance analysis. The physical electronics area encompasses studies of electronic materials, semiconductor and optoelectronic devices, lasers, and photonics.

Computer Engineering

COMP 212 *Intermediate Programming*
COMP 311 *Programming Languages*
ELEC 322 *Applied Algorithms and Data Structures*
ELEC 421 *Operating Systems and Concurrent Programs*
COMP 410 *Software Construction Methodology*
COMP 413 *Distributed Program Construction*
COMP 422 *Parallel Computing*
ELEC 422 *VLSI Design*
ELEC 424 *Computer Systems Design*
ELEC 425 *Computer Systems Architecture*
ELEC 426 *Digital Systems Design*
ELEC 428 *Computer Systems Performance*
ELEC 429 *Introduction to Computer Networks*

Bioengineering

ELEC 481 *Computational Neuroscience*
ELEC 482 *Physiological Control Systems*
ELEC 483 *Introduction to Biomedical Instrumentation and Measurement Techniques*

Systems: Control, Communications, and Signal Processing

ELEC 301 *Introduction to Signals*
ELEC 302 *Introduction to Systems*
ELEC 430 *Communication Theory and Systems*
ELEC 431 *Digital Signal Processing*
ELEC 436 *Control Systems I*

Electronic Circuits and Devices

ELEC 342 *Electronic Circuits*
ELEC 427 *Pulse and Digital Circuits*
ELEC 435 *Electromechanical Devices and Systems*
ELEC 442 *Advanced Electronic Circuits*
ELEC 443 *Power Electronic Circuits*
ELEC 462 *Semiconductor Devices*

Quantum Electronics

PHYS 202 *Quantum Mechanics*
ELEC 306 *Electromagnetic Fields and Devices*
ELEC 361 *Electronic Materials and Quantum Devices*
ELEC 462 *Semiconductor Devices*
ELEC 463 *Lasers and Photonics*
ELEC 465 *Physical Electronics Practicum*
ELEC 563 *Introduction to Solid-State Physics*

The department may add or delete courses in the areas. In addition, graduate courses and equivalent courses from other departments may be used to satisfy area requirements with permission; consult with departmental advisers for the latest information. A course can satisfy only one program requirement. ELEC 491/492 may be used to satisfy requirements in any area, depending on the nature of the design project.

Degree Requirements for B.S. in Electrical Engineering

For general university requirements, see Graduation Requirements (pages 18–20). Students completing the B.S.E.E. program must have a total of at least 134 semester hours in order to graduate.

Basic Mathematics and Science. Students must take all of the courses listed under basic mathematics and science courses. They must also take additional math and science courses, approved by the department, to bring their total to 32 hours.

Core Courses. Students must take all of the courses listed under core courses, except that they need take only 1 of ELEC 301 and COMP 212.

Restricted Electives. 1 computation course and 1 laboratory course.

Specialization Areas. Students in the B.S.E.E. program choose courses from 2 or more specialization areas. Students must take at least 7 specialization courses, including at least 4 courses in one area and courses from at least 2 different areas. Students taking either ELEC 301 or COMP 212 to satisfy a core course requirement may not use that course to satisfy a specialization area requirement. Because of the number of options, students should consult early with department advisers to plan a program that meets their needs. Students going on to a technical career or graduate school may need to use unrestricted electives to create a coherent program.

Design Component. At least 1 of the specialization area courses must be an approved design course.

Degree Requirements for B.A. in Electrical and Computer Engineering

For general university requirements, see Graduation Requirements (pages 18–20). Students completing the B.A. program must have a total of at least 120 semester hours at graduation.

Basic Mathematics and Science. Students in the B.A. program must take all of the courses listed under basic mathematics and science courses, with the following exceptions: CHEM 121 is not required, and MATH 355 Linear Algebra, MATH 381 Introduction to Partial Differential Equations, or CAAM 353 Computational Numerical Analysis may be taken instead of ELEC 331.

Core Courses. All of the courses listed under core courses are required for the B.A. degree, except for COMP 212, ELEC 301, and ELEC 391. Students also have the following options: CAAM 353 Computational Numerical Analysis may be taken instead of MATH 212, and CHEM 121 General Chemistry may be taken instead of PHYS 201.

Restricted Electives. 1 computation course and 1 laboratory course.

Specialization Areas. A 2-course sequence in 1 area and courses from at least 2 areas.

Degree Requirements for M.E.E., M.S., and Ph.D. in Electrical and Computer Engineering

For general university requirements, see Graduate Degrees (pages 62–67). Students should also consult department advisers for specific courses of study.

Master's Degree Programs. A candidate for the professional M.E.E. degree must complete an approved sequence of 10 advanced courses, totaling at least 30 hours. At least 4 of these must be technical courses at the 500 level or higher. At least 7 of the courses must be technical courses at the 400 level or higher. All 10 courses must be at the 300 level or higher and 2 credit hours or more. Specialization is possible in the general areas of bioengineering, signal processing, communication and control theory, electro-optics and physical electronics, and computer science and engineering. A candidate for the M.S. degree must complete both an approved course of study and an approved research program, culminating in an acceptable thesis. (The M.S. degree is not a terminal degree but part of the Ph.D. program.)

A joint M.B.A./Master of Engineering degree is also available in conjunction with the Jesse H. Jones Graduate School of Management.

Ph.D. Program. Candidates should expect to spend a minimum of three academic years of graduate study in this program. Normally, candidates complete the requirements for an M.S. degree as part of the Ph.D. program. For the Ph.D., students must:

- Obtain high standing in an approved course program
- Perform satisfactorily on qualifying examinations
- Complete a satisfactory dissertation of independent and creative research
- Pass a final oral examination

See ELEC in the Courses of Instruction section.