BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING (BSEE) DEGREE

The program leading to the BSEE degree is accredited by the Engineering Accreditation Commission (EAC) of ABET, https://www.abet.org.

Program Learning Outcomes (Student Outcomes) for the BSEE Degree

Upon completing the BSEE degree, students will be able to demonstrate:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Program Educational Objectives for the BSEE Degree

The Bachelor of Science in Electrical Engineering’s (BSEE) degree program strives to provide a high quality degree that emphasizes fundamental principles, responds to the changing demands and opportunities of technology, challenges the exceptional abilities of Rice students, and prepares these students for roles of leadership in their chosen careers.

In support of this goal, the Bachelor of Science in Electrical Engineering’s (BSEE) degree program educational objectives are to produce graduates who:

1. Practice electrical and computer engineering, and related fields, and/or obtain an advanced degree in electrical and computer engineering, and related fields.
2. Use mathematical modeling and problem solving skills in electrical and computer engineering and other technical applications.
3. Analyze, incorporate, and adapt to new technical and scientific developments.
4. Assume increasing professional responsibility and enhance communication and teamwork abilities.

Requirements for the BSEE Degree

For general university requirements, see Graduation Requirements (ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements). Students pursuing the BSEE degree must complete:

- A minimum of 29-31 courses (85 credit hours) to satisfy major requirements.
- A minimum of 134 credit hours to satisfy degree requirements.
- A minimum of 13 courses (39 credit hours) taken at the 300-level or above.
- The requirements for one area of specialization (see below for areas of specialization). The BSEE degree program offers four areas of specialization:
  - Computer Engineering (p. ): provides a broad background in computer systems engineering, including computer architecture, digital hardware engineering, software engineering, and computer systems performance analysis, or
  - Data Science/Systems (p. ): integrates the foundations, tools and techniques involving data acquisition, data analytics, data storage and computing infrastructure in order to enable meaningful extraction of actionable information from diverse and potentially massive data sources. Applications include wireless communication systems, digital signal processing, image processing, and networking, or
  - Neuroengineering (p. 4): exploits engineering techniques to understand, repair, manipulate, or treat the diseases of human neural systems and networks, or
  - Photonics, Electronics, and Nano-devices (p. ): encompasses studies of electronic materials, including nanomaterials, semiconductor and optoelectronic devices, lasers and their applications.

The specialization electives provide the flexibility to create a focus that crosses traditional areas. Ultimately each student’s program must contain a course sequence that provides depth in one area and courses from at least two areas to provide breadth. Because of the number of options, students should consult early with departmental advisors to plan a program that meets their needs. Planning sheets and degree plan forms can be found on the Electrical and Computer Engineering (http://www.ece.rice.edu) website.

The BSEE degree is the usual degree taken by those students planning a career in engineering practice. The BSEE requires more hours and greater depth than the BA degree; however, it still provides considerable flexibility and can reduce the time required to become a licensed professional engineer. In the final year, BSEE students undertake a capstone design project.

Students considering a major offered by the Electrical and Computer Engineering department should take physics (PHYS 101, PHYS 102) and calculus (MATH 101 or MATH 105, MATH 102 or MATH 106) in their freshman year, along with CHEM 121 and COMP 140. The first core courses in the department, ELEC 220, ELEC 241 (lecture) with ELEC 240 (lab), and ELEC 261 are usually taken during the sophomore year, along with more math and science. A course can satisfy only one program requirement. Students entering with advanced placement may have more scheduling options and may take some of these core courses in freshman year. Students who place out of required courses
Bachelor of Science in Electrical Engineering (BSEE) Degree

without transcript credit must substitute other approved courses in the same area. Students should consult with one of the department’s undergraduate advisors in these situations.

The courses listed below satisfy the requirements for this major. In certain instances, courses not on this official list may be substituted upon approval of the major’s academic advisor, or where applicable, the department’s Director of Undergraduate Studies. (Course substitutions must be formally applied and entered into Degree Works by the major’s Official Certifier ([https://registrar.rice.edu/facstaff/degreeworks/officialcertifier](https://registrar.rice.edu/facstaff/degreeworks/officialcertifier)).) Students and their academic advisors should identify and clearly document the courses to be taken.

### Summary

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>Total Credit Hours Required for the Major in Electrical Engineering</td>
<td>85</td>
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</tr>
<tr>
<td>Total Credit Hours Required for the BSEE Degree</td>
<td>134</td>
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### Degree Requirements

#### Core Requirements

Mathematics and Science Courses

- **CHEM 121 & CHEM 123**: GENERAL CHEMISTRY I and GENERAL CHEMISTRY LABORATORY I 4
- **ELEC 261**: ELECTRONIC MATERIALS AND QUANTUM DEVICES 3
- **ELEC 303**: RANDOM SIGNALS IN ELECTRICAL ENGINEERING SYSTEMS 3
- **MATH 101 or MATH 105**: SINGLE VARIABLE CALCULUS I and AP/OTH CREDIT IN CALCULUS I 3
- **MATH 102 or MATH 106**: SINGLE VARIABLE CALCULUS II and AP/OTH CREDIT IN CALCULUS II 3
- **MATH 212 or MATH 221**: MULTIVARIABLE CALCULUS and HONORS CALCULUS III 3

Select 1 from the following:

- **CAAM 335**: MATRIX ANALYSIS 3
- **MATH 354**: HONORS LINEAR ALGEBRA 3
- **MATH 355**: LINEAR ALGEBRA 3

Select 1 from the following:

- **PHYS 101 & PHYS 103**: MECHANICS (WITH LAB) and MECHANICS DISCUSSION 4
- **PHYS 111**: HONORS MECHANICS (WITH LAB) 4

Select 1 from the following:

- **PHYS 102 & PHYS 104**: ELECTRICITY & MAGNETISM (WITH LAB) and ELECTRICITY AND MAGNETISM DISCUSSION 4
- **PHYS 112**: HONORS ELECTRICITY & MAGNETISM (WITH LAB) 4

Approved Electives in Mathematics and Science

Select 1 from the following typically approved courses:

- **BIOC 201**: INTRODUCTORY BIOLOGY 3
- **CAAM 336**: DIFFERENTIAL EQUATIONS IN SCIENCE AND ENGINEERING 3

### Electrical and Computer Engineering (ECE) Core Courses:

- **ELEC 220**: FUNDAMENTALS OF COMPUTER ENGINEERING 4
- **ELEC 241 & ELEC 240**: FUNDAMENTALS OF ELECTRICAL ENGINEERING I and FUNDAMENTALS OF ELECTRICAL ENGINEERING I LABORATORY 4
- **ELEC 242 & ELEC 244**: FUNDAMENTALS OF ELECTRICAL ENGINEERING II and FUNDAMENTALS OF ELECTRICAL ENGINEERING II LABORATORY 4
- **ELEC 301**: SIGNALS, SYSTEMS, AND LEARNING 3
- **ELEC 305**: INTRODUCTION TO PHYSICAL ELECTRONICS 3
- **ELEC 326 / COMP 326**: DIGITAL LOGIC DESIGN 3

#### Computation Course

- **COMP 140 or COMP 130**: COMPUTATIONAL THINKING and ELEMENTS OF ALGORITHMS AND COMPUTATION 4

#### Design Requirements

- **Design Laboratory**: 3
- **ELEC 327**: IMPLEMENTATION OF DIGITAL SYSTEMS 3
- **ELEC 332**: ELECTRONIC SYSTEMS PRINCIPLES AND PRACTICE 3
- **ELEC 364**: PHOTONICS MEASUREMENTS: PRINCIPLES AND PRACTICE 3

#### Design

- **ELEC 494**: SENIOR DESIGN (2 semesters required, 1st semester) 3
- **ELEC 494**: SENIOR DESIGN (2 semesters required, 2nd semester) 3

#### Area of Specialization

Select 1 from the following Areas of Specialization (see Areas of Specialization below):

- Computer Engineering
- Data Science / Systems
- Neuroengineering
- Photonics, Electronics, and Nano-devices

**Total Credit Hours Required for the Major in Electrical Engineering**: 85-86

**University Graduation Requirements**: [ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements](ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements) 49

**Total Credit Hours**: 134
Footnotes and Additional Information

* Includes coursework completed as distribution credit, FWIS, LPAR upper-level, residency (hours taken at Rice), 60 hours outside of the major (if applicable), and any additional academic program requirements. The "hours outside of the major" requirement may include all of the above university requirements.

1 The design requirements (Design Laboratory and Senior Design) are typically taken during the junior and senior years.

2 Design Laboratory is typically taken in the junior year. The required Design Laboratory does not count as a specialization course. It is important to consult a departmental advisor when choosing the Design Laboratory course or if interested in taking a second one.

3 Students must complete the ELEC 494 during both the fall and spring semesters of their senior year. Within the senior design sequence, professional issues and project management for electrical engineers provide instruction in professional engineering topics and the non-technical aspects of the design process, including ethics, design methodology, project planning, technical presentations, and documentation. Both semesters of the senior year are devoted to the team design project using the resources of the Oshman Engineering Design Kitchen (OEDK) through the ELEC 494 course. In the fall semester of the senior year, students finalize their project topics in coordination with the faculty and begin the design project. In the spring semester, students continue in the laboratory to complete their design project. Several presentations and design contests within the ECE department and the School of Engineering occur in the spring in which to showcase the projects.

Areas of Specialization

Students must complete the requirements as listed for one of the following areas of specialization as offered by the BSEE degree program.

A total of 6 courses (minimum of 18 credit hours) must be taken from at least two areas of specialization, including a minimum of 3 courses from one area of specialization, 1 course from an area of specialization outside of the student’s chosen specialization, and 2 courses from any area of specialization. In addition, ELEC graduate coursework at the 500-level may be used to satisfy specialization area requirements with permission. Consult departmental advisors and the Electrical and Computer Engineering (https://www.ece.rice.edu) website for the latest information.

Area of Specialization: Computer Engineering

To fulfill the remaining BSEE degree requirements, students pursuing the Computer Engineering area of specialization must complete:

- a minimum of 3 courses (9 credit hours) from the Computer Engineering area of specialization
- 1 course (3 credit hours) from any area of specialization outside Computer Engineering (from Data Science/Systems, Neuroengineering, or Photonics, Electronics, and Nano-devices)
- 2 courses (6 credit hours) from any area of specialization (including Computer Engineering)

Select a minimum of 3 from the following:

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>COMP 321</td>
<td>INTRODUCTION TO COMPUTER SYSTEMS</td>
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<td>COMP 382</td>
<td>REASONING ABOUT ALGORITHMS</td>
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<tr>
<td>COMP 430</td>
<td>INTRODUCTION TO DATABASE SYSTEMS</td>
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<tr>
<td>COMP 431</td>
<td>TOOLS AND MODELS FOR DATA SCIENCE</td>
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<tr>
<td>COMP 432</td>
<td>INTRODUCTION TO SYSTEMS</td>
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<tr>
<td>ELEC 306</td>
<td>APPLIED ELECTROMAGNETICS</td>
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<tr>
<td>ELEC 400</td>
<td>MODERN COMMUNICATION THEORY AND PRACTICE</td>
<td></td>
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<tr>
<td>ELEC 415</td>
<td>DIGITAL SIGNAL PROCESSING</td>
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<tr>
<td>ELEC 420</td>
<td>MOBILE BIO-BEHAVIORAL SENSING</td>
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<tr>
<td>ELEC 430</td>
<td>ARCHITECTURE FOR WIRELESS COMMUNICATIONS</td>
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<tr>
<td>ELEC 435</td>
<td>INTRODUCTION TO ENERGY-EFFICIENT SYSTEMS</td>
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<tr>
<td>MECH 435</td>
<td>MECHATRONICS</td>
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<tr>
<td>ELEC 436</td>
<td>FUNDAMENTALS OF CONTROL SYSTEMS</td>
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<td>MECH 420</td>
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<tr>
<td>ELEC 437</td>
<td>INTRODUCTION TO COMMUNICATION NETWORKS</td>
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Bachelor of Science in Electrical Engineering (BSEE) Degree

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<tr>
<th>Code</th>
<th>Title</th>
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<tr>
<td>ELEC 438</td>
<td>WIRELESS NETWORKING FOR UNDER-RESOURCED URBAN COMMUNITIES</td>
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<tr>
<td>ELEC 447 / COMP 447</td>
<td>INTRODUCTION TO COMPUTER VISION</td>
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<tr>
<td>ELEC 475</td>
<td>LEARNING FROM SENSOR DATA</td>
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<tr>
<td>ELEC 478</td>
<td>INTRODUCTION TO MACHINE LEARNING</td>
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<tr>
<td>ELEC 498 / COMP 498 / MECH 498</td>
<td>INTRODUCTION TO ROBOTICS</td>
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<tr>
<td>MECH 488</td>
<td>DESIGN OF MECHATRONIC SYSTEMS</td>
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<tr>
<td>STAT 413</td>
<td>INTRODUCTION TO STATISTICAL MACHINE LEARNING</td>
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</tbody>
</table>

Select 1 course from any Area of Specialization outside Data Science/Systems (from Computer Engineering, Neuroengineering, or Photonics, Electronics, and Nano-devices) 3

Select 2 courses from any Area of Specialization (including Data Science/Systems) 6

Total Credit Hours 18

Area of Specialization: Neuroengineering
To fulfill the remaining BSEE degree requirements, students pursuing the Neuroengineering area of specialization must complete:

- a minimum of 3 courses (9 credit hours) from the Neuroengineering area of specialization
- 1 course (3 credit hours) from any area of specialization outside Neuroengineering (from Computer Engineering, Data Science/Systems, or Photonics, Electronics, and Nano-devices)
- 2 courses (6 credit hours) from any area of specialization (including Neuroengineering)

Code | Title                                                   | Credit Hours |
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<tr>
<td>ELEC 380 / BIOE 380 / NEUR 383</td>
<td>INTRODUCTION TO NEUROENGINEERING: MEASURING AND MANIPULATING NEURAL ACTIVITY</td>
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<tr>
<td>ELEC 381 / BIOE 381</td>
<td>FUNDAMENTALS OF NERVE AND MUSCLE ELECTROPHYSIOLOGY</td>
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<tr>
<td>ELEC 382 / NEUR 382</td>
<td>INTRODUCTION TO COMPUTATIONAL NEUROSCIENCE</td>
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<tr>
<td>ELEC 481 / BIOE 481 / NEUR 481</td>
<td>COMPUTATIONAL NEUROSCIENCE AND NEURAL ENGINEERING</td>
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<tr>
<td>ELEC 482 / BIOE 482</td>
<td>PHYSIOLOGICAL CONTROL SYSTEMS</td>
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<tr>
<td>ELEC 483</td>
<td>MACHINE LEARNING AND SIGNAL PROCESSING FOR NEURO ENGINEERING</td>
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<tr>
<td>ELEC 485 / BIOE 485 / COMP 485</td>
<td>FUNDAMENTALS OF MEDICAL IMAGING I</td>
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<tr>
<td>ELEC 486 / BIOE 486 / COMP 486</td>
<td>FUNDAMENTALS OF MEDICAL IMAGING II</td>
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<tr>
<td>ELEC 488 / CAAM 415 / NEUR 415</td>
<td>THEORETICAL NEUROSCIENCE: FROM CELLS TO LEARNING SYSTEMS</td>
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<tr>
<td>ELEC 489 / CAAM 416 / NEUR 416</td>
<td>NEURAL COMPUTATION</td>
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</table>

Select 1 course from any Area of Specialization outside Neuroengineering (from Computer Engineering, Data Science/Systems, or Photonics, Electronics, and Nano-devices) 3

Select 2 courses from any Area of Specialization (including Neuroengineering) 6

Total Credit Hours 18

Area of Specialization: Photonics, Electronics, and Nano-devices
To fulfill the remaining BSEE degree requirements, students pursuing the Photonics, Electronics, and Nano-devices area of specialization must complete:

- a minimum of 3 courses (9 credit hours) from the Photonics, Electronics, and Nano-devices area of specialization
- 1 course (3 credit hours) from any area of specialization outside Photonics, Electronics, and Nano-devices (from Computer Engineering, Data Science/Systems, or Neuroengineering)
- 2 courses (6 credit hours) from any area of specialization (including Photonics, Electronics, and Nano-devices)

Code | Title                                                   | Credit Hours |
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<tr>
<td>ELEC 262</td>
<td>INTRODUCTION TO WAVES AND PHOTONICS</td>
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<tr>
<td>ELEC 306</td>
<td>APPLIED ELECTROMAGNETICS</td>
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<tr>
<td>or PHYS 302 INTERMEDIATE ELECTRODYNAMICS</td>
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<tr>
<td>ELEC 361</td>
<td>QUANTUM MECHANICS FOR ENGINEERS</td>
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<td>or PHYS 311 INTRODUCTION TO QUANTUM PHYSICS I</td>
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<tr>
<td>ELEC 365 / MSNE 365</td>
<td>NANOMATERIALS FOR ENERGY</td>
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<tr>
<td>ELEC 460</td>
<td>PHYSICS OF SENSOR MATERIALS AND NANOSensor TECHNOLOGY</td>
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<td>ELEC 461</td>
<td>SOLID STATE PHYSICS</td>
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<tr>
<td>or PHYS 412 SOLID STATE PHYSICS</td>
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<tr>
<td>ELEC 462</td>
<td>OPTOELECTRONIC DEVICES</td>
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<tr>
<td>PHYS 416</td>
<td>COMPUTATIONAL PHYSICS</td>
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</tbody>
</table>

Select 1 course from any Area of Specialization outside Photonics, Electronics, and Nano-devices (from Computer Engineering, Data Science/Systems, or Neuroengineering) 3

Select 2 courses from any Area of Specialization (including Photonics, Electronics, and Nano-devices) 6

Total Credit Hours 18

Policies for the BSEE Degree
Advising
Rice University provides multiple avenues for undergraduate advising through the Office of Academic Advising, the Rice Residential College system, and academic departments. Although students may consult with their Divisional Advisors in their College during the freshman and sophomore years, they are welcome and encouraged to meet with a major advisor in the Electrical and Computer Engineering Department. In particular, ECE students are required to meet with a major advisor in ECE at least during their junior and senior years to discuss their ECE
Specialization Area course selection and Design Courses. The ECE Undergraduate Committee currently has seven faculty members who serve as major advisors. More information on sample degree plans and on the process for declaring ECE as a major is available on the ECE web site at: https://www.ece.rice.edu/undergraduate-study/academics/bsee-degree-requirements.

Transfer Credit
For Rice University's policy regarding transfer credit, see Transfer Credit (ga.rice.edu/undergraduate-students/academic-policies-procedures/transfer-credit). Some departments and programs have additional restrictions on transfer credit. The Office of Academic Advising maintains the university's official list of transfer credit advisors on their website: https://oaa.rice.edu. Students are encouraged to meet with their academic program's transfer credit advisor when considering transfer credit possibilities.

Departmental Transfer Credit Guidelines
Students pursuing the BSEE degree should be aware of the following departmental transfer credit guidelines:

- Requests for transfer credit will be considered by the program director (and/or the program's official transfer credit advisor) on an individual case-by-case basis.

Additional Information
For additional information, please see the Electrical and Computer Engineering website: https://www.ece.rice.edu/.

Opportunities for the BSEE Degree

Academic Honors
The university recognizes academic excellence achieved over an undergraduate's academic history at Rice. For information on university honors, please see Latin Honors (ga.rice.edu/undergraduate-students/honors-distinctions/university) (summa cum laude, magna cum laude, and cum laude) and Distinction in Research and Creative Work (ga.rice.edu/undergraduate-students/honors-distinctions/university). Some departments have department-specific Honors awards or designations.

Fifth-Year Master's Degree Option for Rice Undergraduate Students
Rice students have an option to pursue the Master of Electrical Engineering (MEE) degree by adding an additional fifth year to their four undergraduate years of science and engineering studies.

Advanced Rice undergraduate students in good academic standing may apply to the MEE degree program during their junior or senior year. Upon acceptance, depending on course load, financial aid status, and other variables, they may then start taking some required courses of the master's degree program. A plan of study will need to be approved by the student's undergraduate advisor and the MEE program director.

As part of this option and opportunity, Rice undergraduate students:

- must complete the requirements for a bachelor's degree and the master's degree independently of each other (i.e. no course may be counted toward the fulfillment of both degrees).
- should be aware there could be financial aid implications if the conversion of undergraduate coursework to that of graduate level reduces their earned undergraduate credit for any semester below that of full-time status (12 credit hours).

Independent Research
The ECE Department encourages our undergraduates to pursue research projects with the faculty. The ECE Department has several opportunities including the multi-year, team-oriented Vertically Integrated Projects (VIP) program through the ELEC 491 course and individual independent research with a faculty member through the ELEC 490 course. For information on taking an undergraduate summer research course tuition free, see: https://summer.rice.edu/academics/ugresearch. Also, there are often summer research opportunities through the NSF funded Research Experience for Undergraduates (REU) program, through individual ECE faculty grants, or through the Smalley-Curl Institute REU Sites program. For more information, see the ECE Department web page at: https://www.ece.rice.edu/undergraduate-program.

Study Abroad
A semester of study abroad is a valuable experience to enhance an individual's perspective on engineering and technology. The ECE Department encourages students to explore this option particularly for the spring semester of the sophomore or junior year. The ECE Department and the University Study Abroad office coordinate to review programs and courses appropriate for Rice engineering students. Additional information is on the ECE Department website at: https://www.ece.rice.edu/undergraduate-study/resources/study-abroad.

Additional Information
For additional information, please see the Electrical and Computer Engineering website: https://www.ece.rice.edu/.

• more information on this Undergraduate - Graduate Concurrent Enrollment opportunity, including specific information on the registration process can be found here (ga.rice.edu/undergraduate-students/academic-opportunities/undergraduate-graduate-concurrent-enrollment).
