ELECTRICAL ENGINEERING, BACHELOR OF SCIENCE

Overview

The Electrical and Computer Engineering (ECE) Department takes a human-centric approach to research and education, with a focus on applications in speech processing, medical imaging, bio-photonics, computer-integrated surgery, renewable energy, human inspired electronic systems for perception and cognition, and other cutting-edge technologies that address real-world problems. Our courses cover wide-ranging topics in three broad areas: signal, systems, and control; electro-physics; and computational systems.

Mission

The Electrical Engineering Program at Johns Hopkins is supported by faculty in the Department of Electrical and Computer Engineering who are committed to providing a rigorous educational experience that prepares students for further study and to professionally and ethically practice engineering in a competitive global environment. Electrical Engineering is concerned with a wide variety of topics in signals, systems and communications, photonics and optoelectronics, and computer engineering. The mission of the program is to provide students with a broad, integrated education in the fundamentals and advanced topics in electrical engineering, basic sciences, mathematics, and humanities in an environment that fosters the development of analytical, computational, and experimental skills, and that involves students in design projects and research experiences; and to provide our electrical engineering graduates with the tools, skills and competencies necessary to understand and apply today's technologies and become leaders in developing and deploying tomorrow's technologies.

Educational Objectives

The Program Educational Objectives (PEOs) for electrical engineering (EE) at the Johns Hopkins University describe what EE graduates are expected to attain within a few years of graduation. The PEOs are determined in consultation with the Electrical and Computer Engineering External Advisory Committee and approved by the ECE faculty.

The educational objectives of the EE program are:

- Our graduates will become successful practitioners in engineering and other diverse careers.
- Some graduates will pursue advanced degree programs in engineering and other disciplines.

ECE Focus Areas for Undergraduate Studies

ECE Students have a lot of flexibility as it relates to their studies. They have the ability to craft a program that is as broad or as specific as they wish. Students who want to deepen their knowledge can do so in seven different areas of the discipline. They are:

1. Computing Systems
2. Integrated Circuits and Microsystems
3. Machine Learning and Artificial Intelligence
4. Medical Imaging
5. Photonics and Optoelectronics
6. Robotics
7. Signals, Systems, and Communication

Classes that fall under each category can be found at https://engineering.jhu.edu/ece/academics/undergraduate-studies/degree-options/study-focus-areas-for-undergraduates/ .

Program Requirements

The Bachelor of Science degree in Electrical Engineering requires a minimum of one hundred and twenty-six (126) credits and a cumulative GPA of 2.0 in ECE coursework. Additional details concerning degree requirements can be found in the Electrical Engineering Advising Manual available at https://engineering.jhu.edu/ece/academics/advising/academics-and-advising/.

The B.S. in Electrical Engineering program is accredited by the Engineering Accreditation Commission of ABET, **http://www.abet.org**, under the General Criteria and the Program Criteria for Electrical, Computer, Communications, Telecommunication(s) and similarly Named Engineering Programs.

The following chart outlines the program requirements.

Code	Title	Credits
Core Electrical & Computer Engineering Courses*		**45**
Must include the following:		
EN.520.123	Computational Modeling for Electrical and Computer Engineering	3
EN.520.142	Digital Systems Fundamentals	3
EN.520.214	Signals and Systems	4
EN.520.219	Introduction to Electromagnetics	3
EN.520.230	Mastering Electronics	3
EN.520.231	Mastering Electronics Laboratory	2
*Additional Required ECE Electives** [1]		*15 - 21*
*Advanced Laboratory and Design Experience Component** [2]		
Select 6 credits of ECE (520) courses from the ECE Advanced Labs (see below).		6
Select 6 credits of ECE or Other Engineering Advanced Labs (see below).		6
"Other Engineering" Courses*		
Courses with E area designation from KSAS or other School of Engineering departments other than ECE, AMS, CLE or General Engineering. Any "Other Engineering" Advanced Labs from the approved list below can be used to also satisfy this requirement. Check with the department for any exceptions.		6
Programming Language Requirement*		
EN.601.220	*Intermediate Programming*	*4*
Mathematics Courses*		**20**
Must include the following:		
AS.110.109	Calculus II (For Physical Sciences and Engineering)	4
AS.110.202	Calculus III	4
or AS.110.211	Honors Multivariable Calculus	
AS.110.201	Linear Algebra	4
or EN.553.291	Linear Algebra and Differential Equations	
or EN.553.295	Linear Algebra for Data Science	

AS.110.302	Differential Equations and Applications	4
EN.553.311	Intermediate Probability and Statistics	4
or EN.553.420	Probability	
Basic Sciences* [3]		**16**
Courses coded NS are not allowed. Introduction to Computing courses may not be used to fulfill the requirement. Must include the following:		
AS.030.101	Introductory Chemistry I	3
AS.171.101	General Physics: Physical Science Major I	4
or AS.171.107	General Physics for Physical Sciences Majors (AL)	
AS.171.102	General Physics: Physical Science Major II	4
or AS.171.108	General Physics for Physical Science Majors (AL)	
AS.173.111	General Physics Laboratory I	1
AS.173.112	General Physics Laboratory II	1
Additional N credits		3
Humanities and Social Sciences		**18**
Select at least six (6), three-credit courses in Humanities or Social Sciences (H/S) including:		
Breath/Depth Requirement		*9*
At least three courses with H/S designation, in a specific area or theme; with at least one course at a 300 level or higher.		
*Writing-Intensive Requirement**		*6*
At least 2 courses/6 credits are required. Courses coded as an H/S can count towards the 18 credit requirement. A grade of C- or better is required.		
*Ethics Requirement**		*3*
Students must take one of these courses. EN.661.315 can also be used to fulfill H/S, Breadth/Depth, and Writing Intensive requirements. EN.660.310 can also be used to fulfill H/S & Breadth/Depth. 660.455 & EN.660.463 can only be used to fulfill the Ethics requirement.		
EN.660.310	Cases in Workplace Ethics	3
EN.660.455	Reimagining The City to Resist Climate Change (No designation code, elective only)	3
EN.660.463	Engineering Management & Leadership (No designation code, elective only)	3
EN.661.315	Culture of the Engineering Profession	3
Electives		
Additional credits to reach 126 credits		

Code	Title	Credits
Approved ECE Advanced Labs		
Six (6) or more credits must be completed from this section. These credits count towards the total required 45 core credits.		
EN.520.363	ECE Ideation and Design Lab	3
EN.520.412	Machine Learning for Signal Processing	3
EN.520.424	FPGA Synthesis Lab	3
EN.520.433	Medical Image Analysis	3
EN.520.440	Machine Intelligence on Embedded Systems	3
EN.520.448	Electronics Design Lab	3
EN.520.450	Advanced Micro-Processor Lab	3
EN.520.454	Control Systems Design	3
EN.520.463	ECE Ideation and Design Lab	3
EN.520.483	Bio-Photonics Laboratory	3
EN.520.491	CAD Design of Digital VLSI Systems I (Juniors/Seniors)	3
EN.520.492	Mixed-Mode VLSI Systems	3
EN.520.495	Microfabrication Laboratory [&]	4
EN.520.498	Senior Design Project	3

Code	Title	Credits
Approved "Other Engineering" Advanced Labs		
Up to six (6) credits can be used to fulfill the advanced lab requirement. Any of these courses can also be used to fulfill the "Other Engineering" requirement.		
EN.510.433	Senior Design Research	3
EN.510.434	Senior Design/Research II	3
EN.530.420	Robot Sensors/Actuators	4
EN.530.421	Mechatronics	3
EN.530.474	Effective and Economic Design for Biomedical Instrumentation	4
EN.540.418	Projects in the Design of a Chemical Car	2
EN.540.419	Projects in the Design of a Chemical Car	2
EN.540.421	Project in Design: Pharmacodynamics	3
EN.540.432	Project in Design: Pharmacokinetics	3
EN.580.311	Design Team Health-Tech Project I	3
EN.580.312	Design Team Health-Tech Project II	3
EN.580.411	Design Team Health-Tech Project I	3
EN.580.412	Design Team Health-Tech Project II	3
EN.580.437	Biomedical Data Design	4
EN.580.438	Biomedical Data Design II	4
EN.580.457	Introduction to Rehabilitation Engineering: Design Lab	3
EN.580.471	Principles of Design of BME Instrumentation	4
EN.580.480	Precision Care Medicine I	4
EN.580.481	Precision Care Medicine II	4
EN.580.493	Imaging Instrumentation	4
EN.580.571	Honors Instrumentation	2
EN.601.315	Databases	3
EN.601.411	Computer Science Innovation & Entrepreneurship II	3
EN.601.415	Databases	3
EN.601.417	Distributed Systems	3
EN.601.421	Object Oriented Software Engineering	3
EN.601.443	Security & Privacy in Computing	3
EN.601.447	Computational Genomics: Sequences	3
EN.601.451	Introduction to Computational Immunogenomics	3
EN.601.454	Introduction to Augmented Reality	3
EN.601.456	Computer Integrated Surgery II	3
EN.601.461	Computer Vision	3
EN.601.466	Information Retrieval and Web Agents	3
EN.601.468	Machine Translation	3
EN.601.471	Natural Language Processing: Self-Supervised Models	3
EN.601.476	Machine Learning: Data to Models	3
EN.601.482	Machine Learning: Deep Learning	4
EN.601.496	Computer Integrated Surgery II - Teams	3

* These courses must be taken for a letter grade.

1 Up to six (6) credits of computer science courses may be used to satisfy this requirement.

2 If CS courses are used to fulfill ECE core requirements (footnote 1) that are also considered advanced labs, they will count towards ECE advanced labs. If you do not want to use those credits towards the advanced lab requirement, please notify the academic program coordinator in the department.

3 If a requirement is waived and no credits are awarded, students must take additional N courses to reach 16 credits.

& EN.520.495 can also be counted as EN.530.495 to be used as an "Other Engineering" Advanced Lab. Please notify the APC or professional academic advisor to adjust degree audit.

Additional information:

- If a student is required to take Gateway Computing prior to taking Intermediate Programming, they must take EN.500.113 Gateway Computing: Python. If Gateway Computing: Java or Matlab are taken, students are required to take EN.500.133 Bootcamp: Python. This course can be used towards major requirements, even though it is listed under S/U grading. Both courses will count as CS, not General Engineering courses, and can be used to fulfill either the ECE Core credit requirement or the "Other Engineering" requirement. Notify your advisor of your intended use.
- Students in the School of Engineering can apply language elements (or beginning/first-year) courses to H/S requirements if they are three credits or more.

The sample program below is very general. Sample programs with an emphasis on computing systems, integrated circuits and microsystems, machine learning & artificial intelligence, medical imaging, photonics and optoelectronics, robotics, and signals & systems can be found in the undergraduate advising manual and at https://engineering.jhu.edu/ece/academics/undergraduate-studies/degree-options/study-focus-areas-for-undergraduates/.

First Year

First Semester	Credits	Second Semester	Credits
AS.110.109[1]	4	AS.171.102 or 108	4
AS.171.101 or 107[2a]	4	AS.173.112	1
AS.173.111	1	EN.500.132	1
EN.520.137	3	EN.520.123	3
EN.500.113	3	EN.520.142	3
Optional HEART course[5]	0-1	AS.110.201	4
	15-16		**16**

Second Year

First Semester	Credits	Second Semester	Credits
AS.110.202 or 211	4	AS.110.201	4
AS.030.101	3	AS.110.302	4
EN.520.219[2b]	3	EN.520.214[2b]	4
EN.520.230	3	EN.520.216	3
EN.520.231	2	EN.520.251	1
H&S 1	3		
	18		**16**

Third Year

First Semester	Credits	Second Semester	Credits
EN.520.344	3	EN.520.353	4
EN.553.311	4	ECE Elective 4	3
Ethics course[4]	3	Basic Science Elective (N)	3
ECE Elective 2	3	H&S 3	3
ECE Elective 3	3	H&S 4	3
	16		**16**

Fourth Year

First Semester	Credits	Second Semester	Credits
Advanced ECE Lab 1	3	Advanced Lab 3[5]	3
Advanced ECE Lab 2	3	Advanced Lab 4[5]	3
ECE Elective 5	3	ECE Elective 6	2
Non-ECE Engineering Elective 1	3	Non-ECE Engineering Elective 2	3
H&S 5	3	H&S 6	3
	15		**14**

Total Credits 126-127

1 Most students will take one of the required math courses each semester for the first two to three years. Students can adjust if they have transferred in or earned credit for math courses through AP exams.

2a Students beginning at the Calculus I level should discuss when to take Physics I and lab with an academic advisor.

2b EN.520.219: Introduction to Electromagnetics (second year fall) and EN.520.214: Signals & Systems (second year spring) require Calculus III as a prerequisite or it can be taken as a co-requisite, in the same semester. Please plan schedules with this in mind.

3 If you are bringing in exam or transfer credit that affords you space in the recommended schedule shown below, you may consider enrolling in an optional HEART or First-Year Seminar (FYS) course during the fall semester. FYS courses carry course numbers EN.501.XXX.

4 Select one of the following to fulfill the ethics requirement:
- EN.660.310 Cases in Workplace Ethics (H designation)
- EN.661.315 Culture of the Engineering Profession (S designation)
- EN.660.455 Reimagining the City in the Face of Climate Change (no designation code
- EN.660.463 Engineering Management & Leadership (no designation code)

5 Can be fulfilled by ECE advanced lab or other engineering advanced lab from the approved checklist.

Learning Outcomes

Students graduating with a B.S. in electrical engineering will have demonstrated:

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.

Each student and faculty advisor must consider these objectives in planning a set of courses and projects that will satisfy degree requirements. The sample programs and the program checklist included in this advising manual illustrate course selections that will help students meet the program objectives.

Faculty and others will assess student performance to ensure that our educational objectives are met. Students will have opportunities to assess their own educational progress and achievements in several ways, including exit interviews and alumni surveys. Through regular review processes, including Academic Council departmental reviews, visits by the departmental external advisory board, course evaluations, and ABET visits; students will have opportunities to discuss their educational experiences and expectations. The outcomes of these assessment processes will be used by the faculty to improve the content and delivery of the educational program.

The success of each student's program will depend on effective faculty advising. Every undergraduate student in the Electrical Engineering Program must follow a program approved by a faculty advisor.