COMPUTER 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 Computer Engineering Program at Johns Hopkins is supported by faculty in the Department of Electrical and Computer Engineering and the Department of Computer Science, 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. The mission of the program is to provide students with a broad, integrated education in the fundamentals and advanced topics in computer 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 computer 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 computer engineering (CE) at the Johns Hopkins University describe what CE 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 CE 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 Computer Engineering requires a minimum of one hundred and twenty-six (126) credits and a cumulative GPA of 2.0 in ECE coursework. Forty-two (42) credits in Computer Engineering, which must include a minimum of 15 ECE credits, 15 CS credits, and 12 credits of ECE/CS electives. Additional details concerning degree requirements can be found in the Computer Engineering Advising Manual available at https://engineering.jhu.edu/ece/academics/advising/academics-and-advising/.

The B.S. in Computer Engineering degree 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 [*]		**15**
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.520.230	Mastering Electronics	3
EN.520.231	Mastering Electronics Laboratory	2
Core Computer Science Courses [*, 1]		**15**
Must include the following:		
EN.601.220	Intermediate Programming	4
EN.601.226	Data Structures	4
EN.601.229	Computer System Fundamentals [2]	3
or EN.520.225	Advanced Digital Systems	
Additional Required ECE & CS Electives*		**6-12**
Advanced Laboratory and Design Experience Component [*]		
Select 6 credits of ECE (520) or CS (601) courses from the ECE & CS Advanced Labs (see below).		6
Select 6 credits of ECE, CS, 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, CS, AMS, CLE or General Engineering. Check with the department for any exceptions. If advanced labs are taken outside of ECE/CS, those credits will count to fulfill this requirement as well.		6
Mathematics Courses [*]		**24**
Must include the following:		
AS.110.109	Calculus II (For Physical Sciences and Engineering)	4
AS.110.202	Calculus III	4
AS.110.201	Linear Algebra	4

or EN.553.291	Linear Algebra and Differential Equations	
or EN.553.295	Linear Algebra for Data Science	
EN.553.171	Discrete Mathematics [3]	4
or EN.601.230	Mathematical Foundations for Computer Science	
EN.553.311	Intermediate Probability and Statistics	4
or EN.553.420	Probability	
Q Elective from Mathematics or Applied Math & Statistics		4
Basic Sciences *		**16**
Courses coded NS are not allowed. Introduction to Computing courses may not be used to fulfill the requirement. If a requirement is waived and no credits are awarded, students must take additional N courses to reach 16 credits of Basic Sciences. This must include the following:		
AS.030.101	Introductory Chemistry I	3
AS.171.101	General Physics: Physical Science Major I	4
AS.171.102	General Physics: Physical Science Major II	4
AS.173.111	General Physics Laboratory I	1
AS.173.112	General Physics Laboratory II	1
N Elective: Any course coded N or EN or QN		3
Humanities and Social Sciences		**18**
Select at least six (6), three-credit courses in Humanities or Social Sciences (H/S) including:		
Breadth & Depth Requirement		*9*
At least three courses with H/S designation, in a specific area or theme, with at least one course at 300 level or higher.		
Writing-Intensive Courses *		*6*
At least 2 courses/6 credits are required. Courses coded as a H/S can count towards the 18 credit requirement.		
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 (Students must take one of these courses. EN.661.315 is the only class that has an H/S designation that can also be used to fulfill Breadth/Depth, and Writing Intensive requirements.)	3
Electives		
Additional credits to reach 126 credits		

Electrical & Computer Engineering or Computer Science Advanced Labs*

A total of 12 credits of advanced lab must be taken. A minimum of six (6) credits must come from ECE (520) or CS (601). The following courses have been approved for use.

Code	Title	Credits
EN.520.363	ECE Ideation and Design Lab	3
EN.520.412	Machine Learning for Signal Processing	3
EN.520.415	Image Process & Analysis II	3
EN.520.424	FPGA Synthesis Lab	3
EN.520.427	Design of Advanced Instruments and Systems	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]	4
EN.520.498	Senior Design Project	3
EN.601.315	Databases	3
EN.601.411	Computer Science Innovation & Entrepreneurship II	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

Other Engineering Advanced Labs*

Students can take up to six credits of the "Other Engineering" Advanced Labs listed below to satisfy the requirement. These courses can also count towards the "Other Engineering" requirement (6 credits) for the major.

Code	Title	Credits
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

* Must be taken for a letter grade.

1 All Gateway Computing and Computing Bootcamp courses will be counted as CS credits. Gateway classes must be taken for a grade. Bootcamp classes can only be taken as S/U but can be used towards core requirements. Please register for the ECE section of Gateway Computing. It is highly recommended that CE students also take EN.500.132 (https://e-catalogue.jhu.edu/search/?P=EN.500.132) Bootcamp: Java. If a student transferring into an ECE major has already taken Gateway Computing: Java or Gateway Computing: Matlab, student must take EN.500.133 Bootcamp: Python.

2 Students can take either EN.601.229 Computer System Fundamentals or EN.520.225 Advanced Digital Systems to fulfill this requirement, but should not take both courses. If EN.520.225 is used, take additional credits from CS to reach the 15 minimum credit requirement.

3 EN.601.230 Mathematical Foundations for Computer Science can only be used to fulfill either Discrete Math (Q) or CS electives (E), but not both.

4 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 the degree audit.

Please note that all EAC ABET-accredited programs require 45 credits of engineering coursework. The credit requirement for this program is met by combining major coursework (42 credits) along with "other engineering" coursework (3 more credits than ABET requires).

The sample program shown is very general. Other sample programs focusing on Microsystems, Computer Integrated Surgery, Software, or Robotics can be found in the advising manual.

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.500.113 (CS Elective #1)	3	EN.520.123	3
EN.520.137	3	EN.520.142	3
Optional HEART course[3]	0-1	EN.601.220	4
	15-16		**16**

Second Year

First Semester	Credits	Second Semester	Credits
AS.030.101	3	AS.110.202 or 211	4
AS.110.201	4	EN.520.214[2b]	4
EN.520.231	2	EN.520.216	3
EN.520.230	3	EN.601.226	4
EN.601.229 or EN.520 225[4]	3	H&S 2	3
H&S 1	3		
	18		**18**

Third Year

First Semester	Credits	Second Semester	Credits
EN.500.132	1	EN.553.311 or 420	4
EN.520.349	3	ECE Elective	3
EN.553.171	4	CS Elective 2	3
EN.661.315	3	Basic Science Elective (N)	3
ECE Elective	4	H&S 4	3
	15		**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
"Other Engineering" Elective 1	3	"Other Engineering" Elective 2	3
Math Elective	4	H&S 6	3
H&S 5	3		
	16		**12**

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 Please note Calculus III is a prerequisite of EN.520.214: Signals & Systems (second year spring) but it can also 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 If you take EN.520.225 Advanced Digital Systems, be sure to take enough CS electives to reach a minimum of 15 CS credits.

5 ECE/CS or non-ECE/CS Engineering Adv. Lab from checklist can be used here. If a non-ECE/CS Advanced Lab is completed, this also fulfills the "Other Engineering" requirement. Students can replace the "Other Engineering" Elective with any other class.

Learning Outcomes

Students graduating with a B.S. in computer 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 Computer Engineering Program must follow a program approved by a faculty advisor.