

Electrical and Computer Engineering, B.S.

Educational Outcomes and Objectives

The B.S. in Electrical and Computer Engineering is a broad and highly flexible degree program structured to provide students with a rich and comprehensive view of the profession. Minimal curriculum constraints enable every student to construct their own unique program of study that fits their professional goals. Students are encouraged to explore multiple areas of theory and application. Our program is accredited by the Engineering Accreditation Commission of ABET, <https://www.abet.org> (<https://www.abet.org/>), under the commission's General Criteria and Program Criteria for Electrical, Computer, Communications, Telecommunication(s) and Similarly Named Engineering Programs. The Faculty of Electrical and Computer Engineering have adopted the following outcomes from ABET and have established the following objectives for the B.S. in Electrical and Computer Engineering curriculum:

Student Outcomes

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.

ECE program Educational Objectives

The ECE program objectives are shown below. They represent our vision for what our students will be doing in their engineering careers five years after they have graduated. The principal behaviors we seek to foster in our students are *expertise*, *innovation* and *leadership*.

Our graduates will be:

Experts

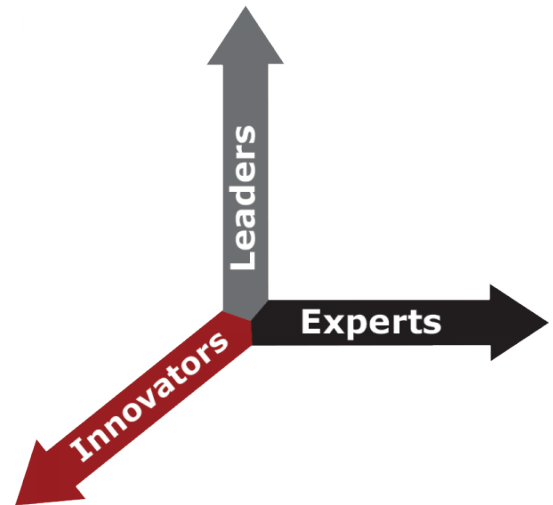
- They will solve problems by applying ECE fundamentals
- Their solutions will reflect depth of understanding in their sophistication.
- Their solutions will reflect breadth of understanding by drawing on multiple disciplines.

Innovators

- They will demonstrate creativity in their engineering practice.
- They will consider holistic systems-oriented approaches in their designs.
- They will think strategically in their planning and execution.

Leaders

- They will take initiative, and demonstrate resourcefulness.
- They will collaborate in multidisciplinary teams.
- They will be leaders in their organizations, their profession and in society.



Three dimensions of objectives for our graduates.

Academic Policies

Policy on ECE Coverage Courses with Fewer than 12 Units

The basic curriculum requirements for Area courses, Coverage and Capstone Design are stated in terms of courses rather than units. The nominal total of 60 units for these categories is determined by assuming that each course is 12 units. In the event that courses with fewer than 12 units are used to satisfy some or all of these requirements, additional courses from the ECE coverage lists must be taken until the total units in ECE courses beyond the core meets or exceeds 60 units. Any ECE coverage course is acceptable, and any excess units beyond the required 60 may be counted as free elective credit.

Prerequisite Grade Requirements

Many ECE courses require a prerequisite course or courses. In most cases, the minimum grade required in a prerequisite to proceed on to the next course is a C. All prerequisites are listed in the registration system.

QPA Requirement and Overload Policy

An overload is defined as any schedule with more than 54 units in one semester. A student will only be permitted to overload by 12 units if she or he achieved an overall QPA of at least 3.5 out of 4.0. If the student's overall QPA is below a 3.5, then the QPA of the previous semester for which he or she is registering will instead be utilized. If that QPA is at least a 3.5 then the student will be permitted to Overload.

Grade Policy for Math Courses

1. CIT states that all mathematics (21-xxx) courses required* for the engineering degree taken at Carnegie Mellon must have a minimum grade of C in order to be counted toward the graduation requirement for the BS engineering degree.

2. A minimum grade of C must be achieved in any required mathematics (21-xxx) course that is a prerequisite for the next higher level required mathematics (21-xxx) course.

3. In addition, ECE requires that 18-202 Mathematical Foundations of Electrical Engineering must be completed with a grade of C or better.

*Elective mathematics courses (like the math/science electives required for ECE) are not included in this policy

Pass/Fail policy

Up to 9 units of StuCo and/or Physical Education courses or other courses taken as Pass/Fail may be used toward Free Electives. ECE core courses may not be taken as pass/fail. ECE project-based courses (including capstone design courses) may not be taken pass/fail. No ECE requirements may be fulfilled using a pass/fail course (except for 99-10x and 18-200)

Other Graduation Requirements

To be eligible to graduate, undergraduate students must complete all course requirements for their program with a cumulative Quality Point Average of at least 2.0. For undergraduate students who enrolled at Carnegie Mellon as freshmen and whose freshman grades cause the cumulative QPA to fall below 2.0, this requirement is modified to be a cumulative QPA of at least 2.0 for all courses taken after the freshman year. Note, however, the cumulative QPA that appears on the student's final transcript will be calculated based on all grades in all courses taken, including freshman year. Students are encouraged to confirm all graduation requirements with their academic advisor.

CIT has the following requirement for graduation. "Students must complete the requirements for their specified degrees with a cumulative quality point average of 2.00 or higher for all courses taken after the freshman year [this is the CIT QPA on the Academic Audit]. In addition, a student is expected to achieve a cumulative quality point average of 2.00 in a series of core departmental courses."

In ECE, this means that the student must complete 18-100 Introduction to Electrical and Computer Engineering, ECE Core, Area Courses, Coverage, and Capstone Design courses with a minimum QPA of 2.0 to graduate. When more than one possibility exists for meeting a specific requirement (e.g., Area Course), the courses used for calculating the ECE QPA will be chosen so as to maximize the QPA. Similarly, when an ECE course is retaken, the better grade will be used in the computation of the minimum QPA for the ECE QPA requirement to graduate.

B.S. in Electrical and Computer Engineering Curriculum

The B.S. in Electrical and Computer Engineering is a broad and highly flexible ABET-accredited (<http://www.abet.org>) degree program offered on the Pittsburgh campus. It is structured to provide students with the smallest set of constraints consistent with a rich and comprehensive view of the profession. Students are encouraged and stimulated to explore multiple areas of theory and application from across the 5 principal undergraduate areas (<https://www.ece.cmu.edu/academics/bs-in-ece/academic-guide.html>) of Electrical and Computer Engineering. The sample curriculum (<http://coursecatalog.web.cmu.edu/schools-colleges/collegeofengineering/departmentofelectricalandcomputerengineering/#samplecurriculumtext>) highlights the flexibility of our curriculum while meeting the requirements listed below.

Minimum Total Units Required for the B.S. in Electrical and Computer Engineering

379

For detailed information and regulations of the curriculum along with the degree requirements and the most recent version of the ECE curriculum and course descriptions, please refer to the ECE Academic Guide (<http://www.ece.cmu.edu/programs-admissions/bachelors/academic-guide/>).

University Requirement

		Units
99-101	Core@CMU	3
		3

CIT Requirements (see CIT section of the catalog for specifics (<http://coursecatalog.web.cmu.edu/schools-colleges/collegeofengineering/>))

CIT General Education	72
21-120 Differential and Integral Calculus	10
21-122 Integration and Approximation	10
One other introductory engineering course (generally taken during the first year)	12
33-141 Physics I for Engineering Students	12
33-142 Physics II for Engineering and Physics Students	12
15-112 Fundamentals of Programming and Computer Science	12
	140

General Technical Requirements

Two Math/Science elective courses ¹	18
Probability Requirement	
21-325 Probability	9
or 36-219 Probability Theory and Random Processes	
or 36-225 Introduction to Probability Theory	
18-202 Mathematical Foundations of Electrical Engineering ²	12
21-127 Concepts of Mathematics ³	12
or 21-128 Mathematical Concepts and Proofs	
15-122 Principles of Imperative Computation ⁴	12
	63

¹ The Math/Science Electives may be satisfied by any course in The Mellon College of Science or the Department of Statistics except for: 100-level courses in Mathematics or Statistics, and courses designed for non-science or engineering majors, such as (but not limited to) 03-132, 09-103, 09-104, 21-240, 21-257, 21-261, 21-350, 33-115, 33-141, 33-124, 33-106, 33-107, 36-200, 36-201, 36-202, 36-203, 36-207, 36-208, 36-209, 36-210, 36-247, 36-309, and 36-310. **Mathematics courses of particular interest to students in ECE are:** 21-228 Discrete Mathematics, 21-241 Matrices and Linear Transformations, 21-259 Calculus in Three Dimensions, and 21-260 Differential Equations.

² This course can also be substituted by a combination of two of the following courses: 21-241, 21-242, 21-254, 21-259, 21-260, 21-268. Note that the combined total will therefore be 18 units.

³ Effective Fall 2022. Prior to Fall 2022, 21-127 was 10 units.

⁴ Effective Summer 2023. Prior to Summer 2023, 15-122 was 10 units.

ECE Course Requirements

For detailed information and regulations along with the degree requirements and the most recent version of the ECE curriculum and course descriptions, please refer to the ECE Academic Guide (<https://www.ece.cmu.edu/academics/bs-in-ece/academic-guide.html>).

		Units
ECE CORE COURSES		
18-100	Introduction to Electrical and Computer Engineering	12
18-200	ECE Sophomore Seminar	1
18-213	Introduction to Computer Systems	12
18-220	Electronic Devices and Analog Circuits	12
18-240	Structure and Design of Digital Systems	12
18-290	Signals and Systems	12
ECE AREA COURSES		
Two Area Courses from 1 of the 5 Areas within ECE		24
One additional Area Course from a second Area		12
ECE COVERAGE COURSES		
One Coverage Course (any additional ECE course or Approved CS course as listed on the ECE web site)		12
ECE CAPSTONE DESIGN		
Any 18-5xx course		12
		121

Free Electives 52 units (typ)*

* For most students, the curriculum above will result in a remainder of 52 units of free electives to achieve the 379 required total units.

A Free Elective is defined as any graded course offered by any academic unit of the university. The large number of units without categorical constraints provides the student, in consultation with their Advisor or Mentor, with the flexibility to design a rich educational program.

Up to 9 units of Student Taught Courses (StuCo) and Physical Education courses, or other courses taken as Pass/Fail, may also be used toward Free Electives.

Transfer of courses from other premier universities may be accepted through submission of the Transfer Credit Request form on the CIT web page (<https://xforms.andrew.cmu.edu/CITTransferCreditRequest>). Please see the CIT website (<https://engineering.cmu.edu/education/academic-policies/undergraduate-policies/transfer-credit.html>) for further information regarding the process.

Sample Curriculum

The table below shows a possible roadmap through our broad and flexible curriculum. The ECE Academic Guide (<https://www.ece.cmu.edu/academics/bs-in-ece/academic-guide.html>) provides further alternatives.

For First-Year requirements, please see the CIT section of the catalog for specifics (<http://coursecatalog.web.cmu.edu/schools-colleges/collegeofengineering/#firstyearforengineeringstudentstext>).

First-Year		Second-Year	
Fall	Spring	Fall	Spring
18-100 Introduction to Electrical and Computer Engineering	Introductory Engineering Course	18-200 ECE Sophomore Seminar	18-2xx ECE Core course
15-112 Fundamentals of Programming and Computer Science *	33-141 Physics I for Engineering Students *	18-2xx ECE Core Course	15-122 Principles of Imperative Computation
21-120 Differential and Integral Calculus *	21-122 Integration and Approximation	21-127 Concepts of Mathematics or 18-202 Mathematical Foundations of Electrical Engineering	18-202 Mathematical Foundations of Electrical Engineering or 21-127 Concepts of Mathematics
76-101 Interpretation and Argument	General Education course	33-142 Physics II for Engineering and Physics Students	36-219 Probability Theory and Random Processes
99-101 Core@CMU		General Education course	General Education course
		39-210 Experiential Learning I	39-220 Experiential Learning II

Third-Year		Fourth-Year	
Fall	Spring	Fall	Spring
18-2xx ECE Core course	18-2xx ECE Core course	18-xxx ECE Coverage course	18-5xx ECE Capstone Design course
18-3xx/4xx ECE Area 1 course (first course in Area)	18-3xx/4xx ECE Area course (either 2nd course from Area 1 or the Area 2 course)	18-3xx/4xx ECE Area course (either 2nd course from Area 1 or the Area 2 course)	General Education course
Math/Science Elective 1	Math/Science Elective 2	General Education course	Free Electives as needed
General Education course	General Education course	Free Elective	Free Elective as needed
Free Elective	Free Elective	Free Elective	Free Elective as needed
39-310 Experiential Learning III			

* Note on AP credit:

Students who have AP credit for **Calculus** and/or **Physics** courses are encouraged to take 21-127 and/or 18-202.

- 21-127 is recommended for students interested in the Hardware Systems (<https://www.ece.cmu.edu/academics/bs-in-ece/academic-guide.html>) or Software Systems (<https://www.ece.cmu.edu/academics/bs-in-ece/academic-guide.html>) areas.
- 18-202 is recommended for students interested in the Device Science and Nanofabrication (<https://www.ece.cmu.edu/academics/bs-in-ece/academic-guide.html>), Signals and Systems (<https://www.ece.cmu.edu/academics/bs-in-ece/academic-guide.html>), or Circuits (<https://www.ece.cmu.edu/academics/bs-in-ece/academic-guide.html>) areas. An alternative to 18-202 is to take **two** other math courses. ECE undergraduates commonly take one or more of: 21-241, 21-259, and 21-260.

Students who have AP credit for **Computer Science A** are encouraged to first take 21-127, then to take 15-122.