Department of Electrical and Computer Engineering

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The field of electrical and computer engineering encompasses a remarkably diverse and expanding set of technologies, including embedded systems, intelligent physical systems, real-time software, distributed computing, mobile computing, cloud computing, digital signal processing, integrated circuits and electronics, computer architecture, intelligent robotic systems, computer-based control systems, telecommunications, computer networking, wireless communication systems, signal and information processing, multimedia systems, solid state physics and devices, microelectromechanical systems (MEMS), electromagnetic and electromechanical systems, and data storage systems. The extraordinary advances in these technologies during the last fifty years have impacted nearly every aspect of society and human activity. These advances have created new products and markets such as “smart” cars, cell phones and mobile computing systems, video games, and advanced medical systems for imaging, diagnosis, testing, and monitoring. These systems and products have served to enhance our quality of life and have also fueled the global economy. In short, the field of electrical and computer engineering has become central to society as we know it.

The Department of Electrical and Computer Engineering at Carnegie Mellon is actively engaged in education and research at the forefront of the existing and emerging technologies. Because of the diverse and broad nature of the field and the significant growth in knowledge in each of its sub areas, it is no longer possible for any single individual to know all aspects of electrical and computer engineering. Nevertheless, it is important that all electrical and computer engineers have a solid knowledge of the fundamentals with sufficient depth and breadth. Society is placing increasing demands on our graduates to apply their skills in new contexts. It is also placing increasing value on engineers who can cross traditional boundaries between disciplines and who can intelligently evaluate the broader consequences of their actions. Our curriculum is designed to produce world-class engineers who can meet these challenges.

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

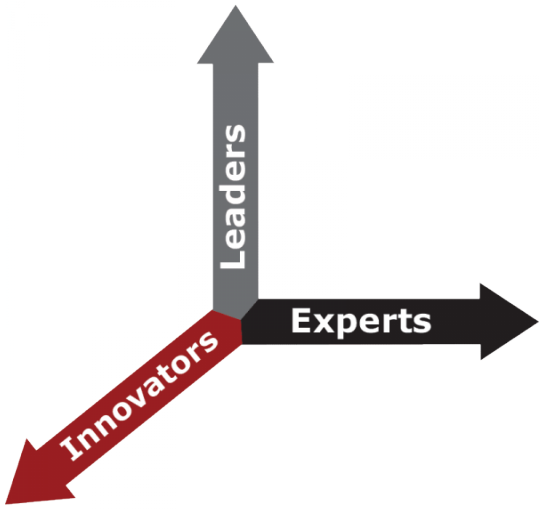
- They will solve problems by applying ECE fundamentals
- Their solutions will reflect depth of understanding in their sophistication.
- Their solutions will reflect breadth of understanding by drawing on multiple disciplines.

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.

Curriculum Overview

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 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/)):

		Units
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 freshman 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:

		Units
Two Math/Science electives [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, 33-120, 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	21-127 Concepts of Mathematics or 18-202 Mathematical Foundations of Electrical Engineering
21-120 Differential and Integral Calculus *	21-122 Integration and Approximation	18-202 Mathematical Foundations of Electrical Engineering or 21-127 Concepts of Mathematics	15-122 Principles of Imperative Computation
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.

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.

Other Opportunities in ECE

ECE Cooperative Education Program

Our Cooperative Education Program invites students to gain valuable experience in employment that relates directly to their major and career goals. At the same time, it provides employers with opportunities to evaluate students as potential full-time employees, while having them complete meaningful projects. Participation in this program is voluntary, and obtaining a cooperative education assignment is competitive.

Due to federal restrictions on student work experiences, international students are not eligible for co-ops. Please visit the ECE CPT page (http://www.ece.cmu.edu/programs-admissions/bachelors/cpt.html) for information regarding international student internships.

The co-op experience

We require a minimum of eight months of co-op experience to identify the work experience as a co-op. Students must have minimally completed their sophomore year to qualify for application to a co-op and should connect with their Academic Advisor for information on how to apply. While on co-op assignment, students are participating in a recognized CIT educational program, retaining their full-time student status, akin to our students who study abroad in established exchange programs (such as EPFL) for one or two semesters. The Cooperative Education Program agreement may be discontinued if the employers do not provide the students with career-related work experience or if the students do not meet the accepted level of performance as defined by the employers.

Upon returning to Carnegie Mellon, the students are required to submit for approval the following two documents to the ECE Undergraduate Office: a three to five page technical report of the Co-Op work, and a one page assessment and evaluation of the Co-Op experience.

Students may obtain more detailed information through the ECE department (http://www.ece.cmu.edu/programs-admissions/bachelors/cooperative-education-program.html) or the Career and Professional Development Center (http://www.cmu.edu/career/).

Teaching Assistantships

Teaching Assistants are a vital part of successful ECE course delivery. All ECE students will receive an email each semester when applications open for the upcoming semester, typically around the date the Schedule of Classes is published. Students are encouraged to communicate with the faculty of any course(s) they are interested in supporting, who can discuss the course expectations and staffing needs. Please see the ECE Teaching Assistantship website (https://www.ece.cmu.edu/insider/teaching-opportunities.html) for further information regarding these opportunities and how to apply.

Integrated M.S./B.S. Degrees Program

The Integrated Master's/Bachelor's program (http://www.ece.cmu.edu/programs-admissions/integrated/) (otherwise known as the IMB program) is an exciting opportunity for students who excel academically to achieve not just a Bachelor's degree in ECE, but also a Master's degree--through our Professional MS degree program--without needing to apply separately. This means no application fee, and no need to take the GRE (Graduate Record Exam). In order to be awarded the MS degree in the IMB program, the student must also earn their BS degree, either simultaneously with the MS degree or at least one semester prior to the awarding of the MS degree. If a course is eligible for the MS degree but must be used to complete the BS degree, the BS degree takes priority over the MS degree.

If a student is at least a 2nd semester junior, has completed at least 270 units and has at least an overall 3.00 QPA, he or she is guaranteed admission into the Professional MS degree in ECE through the IMB program. To be officially admitted, the student must complete the IMB Program form.

If a student does not meet the exact overall 3.00 QPA requirement, he or she is eligible to petition for his or her admission into the IMB program during his or her senior year. Students may obtain the petition forms through a meeting with their assigned academic advisor.

Professional MS Degree Requirements:

Please see the ECE web site for the requirements for the Professional MS degree (https://www.ece.cmu.edu/academics/ms-ece/standard-program.html). For students in the ECE IMB program, all requirements for the Professional MS degree are in addition to the requirements for the BS in ECE. No requirements for the MS degree may be used in any way toward the BS degree, including minors, additional majors or dual degrees.

Transition to graduate status:

Policies regarding completion and certification of the BS degree can be found on the Office of Enrollment Management's Standard Degree Requirements & Degree Certification (https://www.cmu.edu/es/advising-resources/degree-certification.html) webpage. Once the BS degree is certified, a student will be in graduate status for the subsequent term of enrollment. If a student takes more than 8 semesters to complete the BS degree, then he or she must be in graduate status for at least one semester before graduating with the MS degree. Once a student's undergraduate degree has been certified, no more courses may then be applied toward the BS degree. This includes courses toward minors and additional majors, although students pursuing an undergraduate dual degree with another department may still continue to apply additional coursework toward that second degree. Students should consult with Enrollment Services to understand how entering graduate status will affect financial aid, and with their academic advisor to determine a course schedule.

Faculty

DAVID ALLSTOT, Distinguished Special Professor of Electrical and Computer Engineering – Ph.D., University of California at Berkeley; Carnegie Mellon, 2023–

GEORGE AMVROSIADIS, Associate Research Professor of Electrical and Computer Engineering – Ph.D., University of Toronto, Canada; Carnegie Mellon, 2018–

JIM BAIN, Associate Department Head for Academic Affairs and Professor of Electrical and Computer Engineering and Materials Science Engineering; Associate Director, DSSC – Ph.D., Stanford University; Carnegie Mellon, 1993–

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