

Engineering Minors for Non-Engineering Students

Biomedical Engineering Minor

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www.cmu.edu/bme/Academics/undergraduate-programs/minor.html
(https://www.cmu.edu/bme/Academics/undergraduate-programs/minor.html)

The minor program is designed for students who desire exposure to biomedical engineering but may not have the time to pursue the Biomedical Engineering additional major. The program is open to students of **all** colleges and is popular among both engineering and science majors. In conjunction with other relevant courses, the program may provide a sufficient background for jobs or graduate studies in biomedical engineering. Students interested in a medical career may also find this program helpful.

The Biomedical Engineering minor curriculum is comprised of three core courses and three electives. The Quality Point Average (QPA) for courses that count toward the minor must be 2.00 or better. No course taken on a pass/fail or audit basis may be counted towards the minor.

Students who have questions or are interested in declaring Biomedical Engineering minor should contact Kristin Kropf (kgaluska@andrew.cmu.edu).

Requirements

Minimum units required for minor:	57
03-121 Modern Biology	9
or 03-151 Honors Modern Biology	
42-101 Introduction to Biomedical Engineering	12
42-202 Physiology	9
42-xxx BME Elective I	9-12
42-xxx BME Elective II	9-12
42-xxx BME Elective III	9-12

A BME Elective is defined as one of the following:

1. One semester of 42-200 Sophomore BME Research Project, 42-300 Junior BME Research Project, 42-400 Senior BME Research Project or 39-500 Honors Research Project. The project must be supervised by a core or courtesy Biomedical Engineering faculty member and for 9 or more units. Research projects supervised by a courtesy Biomedical Engineering faculty member must have significant biomedical engineering relevance. Note that BME Research Project can only be count as one BME elective.

2. 42-203 BME Laboratory (or the cross-listed version 03-206 for students in the Health Professions Program). Please note that priority for enrollment in 42-203 or 03-206 will be given to students who have declared the Additional Major in Biomedical Engineering. If sufficient room in the course remains after all majors have been accommodated in a given semester, students who have declared the Biomedical Engineering Designated Minor will be given the next priority for enrollment. If space still allows, other students will be enrolled.

3. Any 42-xxx course with a course number greater than 42-300 and worth at least 9 units (excluding 42-300 and 42-400- see previous comment regarding BME Research Project).

Students can petition the Biomedical Engineering Undergraduate Affairs Committee to count non-BME classes that have significant biological or medical content towards the minor requirements.

Engineering Studies Minor

(for non-engineering students)

Kurt Larsen, *Director*
Location: Scaife Hall 426

Carnegie Mellon undergraduate students enrolled in colleges other than engineering can complete a Minor in Engineering Studies in addition to their regular majors. Students pursuing this minor are required to complete courses from at least two different engineering departments in order to assure some breadth of exposure to engineering. In addition, the minor provides students the opportunity to pursue an in-depth concentration in a particular field of engineering.

For the Minor in Engineering Studies, students must complete five engineering courses as follows and must earn a cumulative QPA of 2.00 in these five courses. Students may declare the minor by contacting the director after they have successfully completed one introductory engineering courses (from list #1 below).

Requirements

- At least one and up to three of the following:

12-100	Exploring CEE: Infrastructure and Environment in a Changing World	12
18-100	Introduction to Electrical and Computer Engineering	12
19-101	Introduction to Engineering and Public Policy	12
24-101	Fundamentals of Mechanical Engineering	12
27-100	Engineering the Materials of the Future	12
42-101	Introduction to Biomedical Engineering	12
- Four engineering-centric courses of at least nine units each. Students must demonstrate both breadth and depth by taking courses from at least two of the below departments; and at least two courses from the same department.
 - Biomedical Engineering
 - Chemical Engineering
 - Civil and Environmental Engineering
 - Electrical and Computer Engineering
 - Engineering Design, Innovation, and Entrepreneurship
 - Engineering and Public Policy*
 - Materials Science and Engineering
 - Mechanical Engineering

Up to one of the following Robotics courses can count toward the ES minor. But it cannot be double-counted with the Robotics minor or double major.

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| 16-311 | Introduction to Robotics | 12 |
| 16-362 | Mobile Robot Algorithms Laboratory | 12 |
| 16-384 | Robot Kinematics and Dynamics | 12 |
| 16-385 | Computer Vision | 12 |
| 16-421 | Vision Sensors | 12 |
| 16-474 | Robotics Capstone | 12 |
| 16-350 | Planning Techniques for Robotics | 12 |

NOTE: The following courses may NOT be included as part of the minor in Engineering Studies.

06-262	Mathematical Methods of Chemical Engineering	12
12-201	Geology	9
15-213	Introduction to Computer Systems	12
18-090	Twisted Signals: Multimedia Processing for the Arts	10
18-200	ECE Sophomore Seminar	1
18-202	Mathematical Foundations of Electrical Engineering	12
18-213	Introduction to Computer Systems for a core major requirement (e.g. CS minor)	12

24-280	Special Topics: C++ Programming for Engineers	9
24-291	Environmental Systems on a Changing Planet	9
24-311	Numerical Methods	10
42-202	Physiology	9

Double counting of core courses in student's primary major is not permitted.

*Because of the nature of the courses offered by Engineering and Public Policy, only two EPP courses (including 19-101) can be used toward the minor requirements. Most EPP courses (19-xxx) are not permissible for the minor; students need special permission to use 19-xxx toward this minor and should contact the director for prior approval. Students interested in EPP coursework should consider the Technology and Policy minor instead.

Technology and Policy Minor

Deanna H. Matthews, Associate Department Head for Undergraduate Affairs, Engineering and Public Policy
Location: Wean Hall 4101

The Technology and Policy Minor is administered by the Department of Engineering and Public Policy (EPP). The Technology and Policy Minor is designed to give students a basic understanding of the interactions between technology, society and policy and some project experience in problems involving technology and policy.

Pre-requisites

Students should have prerequisite knowledge in economics (73-102 Principles of Microeconomics or similar level economics course) and statistics (36-202 Methods for Statistics & Data Science or similar level statistics course) in order to pursue the Technology and Policy Minor.

Course Requirements

19-101	Introduction to Engineering and Public Policy	12
19-301	Decision Making Methods for Engineers and Scientists or other approved Decision Science course	9
or 19-351	Applied Methods for Technology-Policy Analysis	
19-451	EPP Projects I	12
xx-xxx	Two EPP Technology-Policy Electives	18

EPP Technical Electives include courses that address problems at the society-technology interface and the means of analyzing these issues. A list of qualifying Technology-Policy electives is assembled each semester and is available from the EPP Department. Example Technology-Policy electives include:

19-211	Ethics and Policy Issues in Computing	9
19-303	Cryptocurrencies, Blockchains and Applications	Var.
19-403	Policies of Wireless Systems	12
19-411	Science and Innovation Leadership for the 21st Century: Firms, Nations, and Tech	9
19-425	Sustainable Energy for the Developing World	9
19-429	Climate Change Science and Solutions	9
19-433	Data Science for Technology, Innovation and Policy	9
19-469	Behavior, Decision and Policy	9
19-639	Policies of the Internet	12
19-668	Electric Vehicles: Technology, Economics, Environment and Policy	12

Students must earn a cumulative QPA of 2.0 in all courses taken for the minor. Required courses taken for a student's primary major may not be counted toward the Technology and Policy Minor. Elective courses for a student's primary major or courses fulfilling general education requirements may be counted, however.

Information Security, Privacy and Policy Minor

Lujo Bauer, Professor, Electrical and Computer Engineering and Software and Societal Systems Department (SCS)

Deanna H. Matthews, Associate Department Head for Undergraduate Affairs, Engineering and Public Policy

Interdisciplinary minor offered by both CIT and SCS

There is a growing demand for security and privacy experts, and increasing interest among CMU undergraduates in taking security and privacy courses. Security and privacy expertise is an asset in a variety of careers outside, not just in computer science, but also in areas that include business, management, and law. In addition, the policy side of security and privacy is becoming increasingly important and employers are interested in hiring people with an understanding of relevant policy issues, especially in the privacy and security area.

This minor is for undergraduate students across the university who are interested in policy issues related to security and privacy, including those who are planning careers in security/privacy as well as those who plan to focus their careers in other areas. The curriculum has been designed to accommodate students from any major as long as they have taken at least one introductory-level college programming course (such as 15-110 or 15-112).

After completing this minor, students will have a good understanding of how to identify potential security and privacy risks and relevant legal and policy issues; a working understanding of security topics such as cryptography, authentication, and Internet security protocols; as well as broad knowledge of several security- and privacy-related areas as they pertain to the design, development, deployment and management of technologies in a variety of practical contexts (e.g., Web, mobile, Internet of Things, social media, crypto currencies).

Admission

Students are not required to apply to enroll in this minor to start the required courses. However, they are encouraged to consult with the minor director on their elective course selection. In addition, students doing the independent study option must get approval from the minor director prior to enrolling in their independent study course. Finally, students must contact the minor director to certify their completion of the minor.

Curriculum

Students are required to take five courses to complete this minor with a minimum of 48 units.

INTRODUCTORY SECURITY COURSE

17-331	Information Security, Privacy, and Policy	12
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Students who have taken 15-213 Introduction to Computer Systems may substitute 15-330 Introduction to Computer Security/18-330 Introduction to Computer Security

PRIVACY AND POLICY COURSE

17-333	Privacy Policy, Law, and Technology	9
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Students may substitute a 12-unit version of this course: 19-608, 17-333, or 95-818.

PRIVACY ELECTIVES

Complete a minimum of 9 units:

19-534/17-334	Usable Privacy and Security	9
19-602/17-702	Current Topics In Privacy Seminar	3
17-731	Foundations of Privacy	12

TECHNOLOGY AND POLICY ELECTIVES

Complete a minimum of 9 units:

19-211	Ethics and Policy Issues in Computing	9
17-562	Law of Computer Technology	9
19-101	Introduction to Engineering and Public Policy	12
19-402	Telecommunications Technology and Policy for the Internet Age	12
19-403	Policies of Wireless Systems	12
19-639	Policies of the Internet	12
84-387	Remote Systems and the Cyber Domain in Conflict	9

Crosslisted courses are also allowed.

ADDITIONAL APPROVED ELECTIVE

Students must complete an additional elective of 9 units or more. Students may choose an additional privacy elective or technology policy elective from the list above, or the one of the following security electives:

15-316	Software Foundations of Security and Privacy	9
15-356	Introduction to Cryptography	12

19/17-303	Cryptocurrencies, Blockchains and Applications	Var.
19-534/17-334	Usable Privacy and Security	9
18-334	Network Security	12
18-335	Secure Software Systems	12
18-435	Foundations of Blockchains	12

Students who have the necessary prerequisites may choose any approved elective from the SCS or ECE security and privacy undergraduate concentration. Check with the minor program director to determine which category of elective each course will fulfill.

Students should be careful to choose electives for which they have appropriate prerequisites. New elective options are expected as more courses are offered. Students may petition to count a course not on this list as an elective. Students should request permission *before* taking a course that is not on this list. Students may not count multiple electives that overlap substantially.

Optional Project: Subject to approval by the minor director, students may optionally count towards one of the elective requirements 9 units of an independent study or research project course in the security or privacy area, under the supervision of a faculty member in any department.

In order to receive credit towards the minor, students must submit a brief project proposal to their project advisor and to the minor director and have it approved prior to conducting the project. Depending on the topic of the project, the minor director may approve credits counting towards privacy electives, technology policy electives, security electives, or some combination of these. Students may work individually, with other undergraduates, or as part of project teams with graduate students or research staff. Students involved in a group project must identify specific project components for which they are responsible. In addition, they must submit a final project report to their project advisor and the minor director that includes a literature review and describes the work they completed. Students working on a group project must each submit their own final report, which should also situate their contribution in the context of the larger project. Note, students are expected to work approximately 1 hour per week for each unit of project in which they are enrolled (e.g. 9 units = 9 hours/week of project work).

Double Counting: At most 2 of the courses used to fulfill the minor requirements may be counted towards any other undergraduate major or minor program. This rule does not apply to courses counted for general education requirements.