Engineering Minors for Non-Engineering Students

Biomedical Engineering Minor
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www.bme.cmu.edu (http://www.bme.cmu.edu/)

The minor program is designed for engineering students who desire exposure to biomedical engineering but may not have the time to pursue the Biomedical Engineering additional major. The program is also open to students of all colleges and is popular among 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. Students pursuing the minor may contact the BME Associate Head for Education (https://www.cmu.edu/bme/People/Faculty/profile/czapanta.html) or the Biomedical Engineering Undergraduate Program Coordinator (https://www.cmu.edu/bme/People/Administration/).

Requirements

Minimum units required for minor: 57

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>or 03-151</td>
<td>Honors Modern Biology</td>
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</tr>
<tr>
<td>42-101</td>
<td>Introduction to Biomedical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>42-202</td>
<td>Physiology</td>
<td>9</td>
</tr>
<tr>
<td>42-xxx</td>
<td>BME Elective I</td>
<td></td>
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<tr>
<td>42-xxx</td>
<td>BME Elective II</td>
<td></td>
</tr>
<tr>
<td>42-xxx</td>
<td>BME Elective III</td>
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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 120

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

1. 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
   - 06-100 Introduction to Chemical Engineering 12

2. Four 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 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.
   - 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

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

<table>
<thead>
<tr>
<th>Course</th>
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<th>Units</th>
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</thead>
<tbody>
<tr>
<td>06-262</td>
<td>Mathematical Methods of Chemical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>12-201</td>
<td>Geology</td>
<td>9</td>
</tr>
<tr>
<td>12-421</td>
<td>Engineering Economics</td>
<td>6</td>
</tr>
<tr>
<td>15-213</td>
<td>Introduction to Computer Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-090</td>
<td>Twisted Signals: Multimedia Processing for the Arts</td>
<td>10</td>
</tr>
<tr>
<td>18-099</td>
<td>Special Topics: Mobile App Design &amp; Development</td>
<td>12</td>
</tr>
<tr>
<td>18-200</td>
<td>ECE Sophomore Seminar</td>
<td>1</td>
</tr>
<tr>
<td>18-202</td>
<td>Mathematical Foundations of Electrical Engineering</td>
<td>12</td>
</tr>
</tbody>
</table>
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

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

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 Technology and Policy of Cyber War 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 9

19-534/17-334 Usable Privacy and Security 9

18-335 Secure Software Systems 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.