Biomedical Engineering Overview

Biomedical engineering education at Carnegie Mellon University reflects the belief that a top biomedical engineer must be deeply trained in both a traditional engineering practice and biomedical sciences. The unique additional major program leverages extensive collaborations with sister departments in the College of Engineering and with major medical institutions in Pittsburgh. This collaborative approach, combined with a rigorous engineering education, confers unique depth and breadth to the education of Biomedical Engineering graduates.

Students who elect Biomedical Engineering as a major must also declare a major in one of the traditional engineering disciplines: Chemical Engineering, Civil & Environmental Engineering, Electrical & Computer Engineering, Materials Science & Engineering, or Mechanical Engineering.

The curriculum, demanding but readily feasible to complete in four years, is highly rewarding to motivated students.

Common Requirements for the Additional Major

The Biomedical Engineering additional major program takes advantage of curricular overlaps between Biomedical Engineering and traditional engineering majors, such that the additional major can be completed in four years with only a modest increase in course requirements. The requirements for Biomedical Engineering consist of the core, the tracks, and the capstone design course. The core exposes students to basic facets of biomedical engineering to lay a foundation. The tracks allow students to build depth in a specific aspect of biomedical engineering. The capstone design (https://www.cmu.edu/bme/Academics/undergraduate-programs/Resources/undergrad_design.html) project engages students in teamwork to develop real-world applications.

The additional major in Biomedical Engineering should be declared at the same time when declaring a traditional engineering major.

Course Requirements for the Additional Major

Minimum units required for additional major: 93–102

Students majoring in Biomedical Engineering must meet three sets of requirements:

1. Biomedical Engineering (BME)
2. A traditional engineering discipline, and

The Quality Point Average (QPA) for courses that count toward the additional major must be 2.00 or better. No course taken on a pass/fail or audit basis may be counted towards the additional major.

The course requirements for the BME portion of the additional major are as follows:

Core Courses

**(all required)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121 Modern Biology- Fall and Spring</td>
<td>9</td>
</tr>
<tr>
<td>or 03-151 Honors Modern Biology</td>
<td></td>
</tr>
<tr>
<td>42-101 Introduction to Biomedical Engineering- Fall and Spring</td>
<td>12</td>
</tr>
<tr>
<td>42-201 Professional Issues in Biomedical Engineering- Fall and Spring</td>
<td>3</td>
</tr>
<tr>
<td>42-202 Physiology- Fall and Spring</td>
<td>9</td>
</tr>
<tr>
<td>42-203 Biomedical Engineering Laboratory- Fall and Spring</td>
<td>9</td>
</tr>
<tr>
<td>#</td>
<td></td>
</tr>
<tr>
<td>42-302 Biomedical Engineering Systems Modeling and Analysis- Fall and Spring</td>
<td>9</td>
</tr>
<tr>
<td>42-401 Foundation of BME Design- Fall*</td>
<td>6</td>
</tr>
<tr>
<td>42-402 BME Design Project- Spring</td>
<td>9</td>
</tr>
</tbody>
</table>

# Also known as 03-206 for Health Professions Program (http://www.cmu.edu/hpp/) students.

* 42-401 serves as the precursor/pre-requisite for 42-402 BME Design Project.

Tracks (Completion of one track is required)

- Biomaterials and Tissue Engineering (BMTE) (https://www.cmu.edu/bme/Academics/undergraduate-programs/bmte_track.html)
- Biomechanics (BMEC) (https://www.cmu.edu/bme/Academics/undergraduate-programs/bmec_track.html)
- Biomedical Devices (BMDV) (https://www.cmu.edu/bme/Academics/undergraduate-programs/bmdv_track.html)
- Biomedical Signal and Image Processing (BSIP) (https://www.cmu.edu/bme/Academics/undergraduate-programs/bsip_track.html)
- Cellular and Molecular Biotechnology (CMBT) (https://www.cmu.edu/bme/Academics/undergraduate-programs/cmbt_track.html)
- Neuroengineering (NRO) (https://www.cmu.edu/bme/Academics/undergraduate-programs/neuro_track.html)
- Self-Designed Biomedical Engineering (SBME) (https://www.cmu.edu/bme/Academics/undergraduate-programs/sbme_track.html)

Biomaterials and Tissue Engineering (BMTE) Track

**Overview**

The BMTE track addresses issues at the interface of materials science, biology and engineering. The topics include the interactions between materials and cells or tissues, the effects of such interactions on cells and tissues, the design of materials for biological applications, and the engineering of new tissues.

**Targets**

The BMTE track is ideal for students interested in combining the education of Biomedical Engineering with Materials Science & Engineering or with Chemical Engineering. Both provide the necessary foundation in chemistry and/or materials science. Students of this track may develop careers in biotechnology, tissue engineering, biopharmaceuticals, and medical devices that leverage materials properties.

**Requirements**

In addition to the Biomedical Engineering core courses, students in the BMTE Track must take the following combination of three courses:

- One (1) Required BMTE elective
- Two (2) BMTE Electives (either Required or Additional)
BMTE Electives

Required BMTE Electives (must take one of the following)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-610</td>
<td>Introduction to Biomaterials</td>
<td>9</td>
</tr>
<tr>
<td>42-611/27-709</td>
<td>Engineering Biomaterials</td>
<td>12</td>
</tr>
<tr>
<td>42-612/27-520</td>
<td>Tissue Engineering</td>
<td>12</td>
</tr>
<tr>
<td>42-670</td>
<td>Special Topics: Biomaterial Host Interactions in Regenerative Medicine</td>
<td>12</td>
</tr>
</tbody>
</table>

**Please note that 42-610 will NOT count as an MSE technical elective**

Additional BMTE Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-320</td>
<td>Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>42-613</td>
<td>Polymeric Biomaterials</td>
<td>12</td>
</tr>
<tr>
<td>42-620</td>
<td>Engineering Molecular Cell Biology</td>
<td>12</td>
</tr>
<tr>
<td>42-624</td>
<td>Biological Transport and Drug Delivery</td>
<td>9</td>
</tr>
<tr>
<td>42-643</td>
<td>Microfluidics</td>
<td>12</td>
</tr>
<tr>
<td>42-673</td>
<td>Special Topics: Stem Cell Engineering</td>
<td>9</td>
</tr>
<tr>
<td>42-676</td>
<td>Bio-nanotechnology: Principles and Applications</td>
<td>9</td>
</tr>
<tr>
<td>42-681</td>
<td>Disease Models for Therapeutic Discovery</td>
<td>9</td>
</tr>
<tr>
<td>42-x00</td>
<td>BME Research* or 39-500 CIT Honors Research Project* or 42-6XX Clinical Course (Surgery for Engineers/Precision Medicine/ICU Medicine)</td>
<td>9-12</td>
</tr>
</tbody>
</table>

* The 42-x00 research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 CIT Honors Research Project) must be on a BME topic that is aligned to the track, supervised or co-supervised by a BME faculty member, and conducted for 9 or more units of credit.

Some Special Topics and newly offered or intermittently offered courses may be acceptable as BMTE track electives. Students should consult with their BME advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as BMTE track electives.

Sample schedules can be found on the BMTE (https://www.cmu.edu/bme/Academics/undergraduate-programs/bmte_track.html) page on the BME website.

Biomechanics (BMEC) Track

Overview

The BMEC track addresses the application of solid or fluid mechanics to biological and medical systems. It provides quantitative understanding of the mechanical behavior of molecules, cells, tissues, organs, and whole organisms. The field has seen a wide range of applications from the optimization of tissue regeneration to the design of surgical and rehabilitation devices.

Targets

The BMEC track is ideally suited to the combined education of Biomedical Engineering and Mechanical Engineering or Civil & Environmental Engineering. Both provide the necessary foundation in the underlying physical principles and their non-Biomedical Engineering applications. This track may also appeal to students of Electrical & Computer Engineering who are interested in biomedical robotics. Education in biomechanics enables students to pursue careers in medical devices or rehabilitation engineering.

Requirements

In addition to the Biomedical Engineering core courses, students in the BMEC Track must take the following combination of three courses:

- One (1) Required BMEC Elective
- Two (2) BMEC Electives (either Required or Additional)

BMEC Electives

Required BMEC Electives (must take at least one of the following)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-649</td>
<td>Introduction to Biomechanics</td>
<td>12</td>
</tr>
<tr>
<td>42-645/24-655</td>
<td>Cellular Biomechanics</td>
<td>9</td>
</tr>
<tr>
<td>42-648</td>
<td>Cardiovascular Mechanics</td>
<td>12</td>
</tr>
<tr>
<td>42-691</td>
<td>Biomechanics of Human Movement</td>
<td>12</td>
</tr>
</tbody>
</table>

Additional BMEC Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-868</td>
<td>Biomechanics and Motor Control</td>
<td>12</td>
</tr>
<tr>
<td>42-444</td>
<td>Medical Devices</td>
<td>9</td>
</tr>
<tr>
<td>42-447</td>
<td>Rehabilitation Engineering</td>
<td>9</td>
</tr>
<tr>
<td>42-640/24-658</td>
<td>Image-Based Computational Modeling and Analysis</td>
<td>12</td>
</tr>
<tr>
<td>42-643</td>
<td>Microfluidics</td>
<td>12</td>
</tr>
<tr>
<td>42-x00</td>
<td>BME Research* or 39-500 CIT Honors Research Project* or 42-6XX Clinical Course (Surgery for Engineers/Precision Medicine/ICU Medicine)</td>
<td>9-12</td>
</tr>
</tbody>
</table>

* The 42-x00 research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 CIT Honors Research Project) must be on a BME topic that is aligned to the track, supervised or co-supervised by a BME faculty member, and conducted for 9 or more units of credit.

Some Special Topics, newly offered or intermittently offered courses may be acceptable as track electives. Students should consult with their advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives.

Sample schedules can be found on the BMEC (https://www.cmu.edu/bme/Academics/undergraduate-programs/bmec_track.html) page on the BME website.

Biomedical Devices (BMDV) Track

Overview

The BMDV track addresses issues at the interface of medicine and engineering. The topics include biomedical sensors, actuators, diagnostic devices, therapeutic devices, instruments, systems, and fundamental topics of device material, device fabrication, and device interaction with biological cells, tissues and organs. The Biomedical Device track will prepare students for leaders in the biomedical device industry and for further education in graduate/medical schools.

Targets

The BMDV track will prepare students to be leaders in the biomedical device industry and for further education in graduate/medical schools. It is ideal for students interested in combining the education of Biomedical Engineering with Electrical and Computer Engineering, or with Mechanical Engineering, or with Materials Science & Engineering.

Requirements

In addition to the Biomedical Engineering core courses, students in the BMDV Track must take the following combination of three courses:

- One (1) Required BMDV Elective
- Two (2) BMDV Electives (either Required or Additional)

BMDV Electives

Required BMDV Electives (must take at least one of the following)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-678</td>
<td>Medical Device Innovation and Realization</td>
<td>12</td>
</tr>
<tr>
<td>42-682</td>
<td>Bioinstrumentation</td>
<td>12</td>
</tr>
<tr>
<td>42-693</td>
<td>Special Topics in Integrated Systems Technology: Micro/Nano Biomedical Devices</td>
<td>12</td>
</tr>
<tr>
<td>42-694</td>
<td>Engineering Principles of Medical Devices</td>
<td>9</td>
</tr>
</tbody>
</table>

Additional BMDV Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-467</td>
<td>Human Robot Interaction</td>
<td>12</td>
</tr>
<tr>
<td>18-412</td>
<td>Neural Technology: Sensing and Stimulation</td>
<td>12</td>
</tr>
<tr>
<td>16-879</td>
<td>Medical Robotics</td>
<td>12</td>
</tr>
<tr>
<td>18-416</td>
<td>Nano-Bio-Photonics</td>
<td>12</td>
</tr>
<tr>
<td>42-444</td>
<td>Medical Devices</td>
<td>9</td>
</tr>
<tr>
<td>42-447</td>
<td>Rehabilitation Engineering</td>
<td>9</td>
</tr>
<tr>
<td>42-689</td>
<td>Introduction to Medical Imaging</td>
<td>9</td>
</tr>
<tr>
<td>42-648</td>
<td>Cardiovascular Mechanics</td>
<td>12</td>
</tr>
<tr>
<td>42-675</td>
<td>Fundamentals of Computational Biomedical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>42-676</td>
<td>Bio-nanotechnology: Principles and Applications</td>
<td>9</td>
</tr>
<tr>
<td>42-688</td>
<td>Introduction to Neural Engineering</td>
<td>12</td>
</tr>
</tbody>
</table>
Biomedical Signal and Image Processing (BSIP) Track

**OVERVIEW**

The BSIP track addresses biomedical phenomena based on the information embedded in sensor-detected signals, including digital images and nerve electrical pulses. Students in this track will gain an understanding of the technologies involved in acquiring signals and images, the mathematical principles underlying the processing and analysis of signals, and the applications of signal/image processing methods in basic research and medicine.

**TARGETS**

This track aligns most naturally with a combined education of Biomedical Engineering and Electrical & Computer Engineering, which lays a solid foundation in signal processing principles. This track prepares students for careers in medical imaging or smart prosthetics. It also interfaces with many clinical practices including radiology, neurology/neurosurgery, and pathology.

**REQUIREMENTS**

In addition to the Biomedical Engineering core courses, students in the BSIP Track must take the following combination of three courses:

- One (1) **Required** BSIP elective
- Two (2) BSIP Electives (either **Required** or **Additional**)

**BSIP ELECTIVES**

Required BSIP Electives (must take at least one of the following)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-610</td>
<td>Introduction to Biomaterials</td>
<td>9</td>
</tr>
<tr>
<td>42-64X</td>
<td>Clinical Course (Surgery for Engineers/ Precision Medicine/ICU Medicine)</td>
<td>9</td>
</tr>
<tr>
<td>42-600</td>
<td>BME Research* or 39-500 CIT Honors Thesis</td>
<td>9</td>
</tr>
</tbody>
</table>

* The 42-x00 research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 CIT Honors Research Project) must be on a BME topic that is aligned to the track, supervised or co-supervised by a BME faculty member, and conducted for 9 or more units of credit.

Some Special Topics, newly offered or intermittently offered courses may be acceptable as track electives. Students should consult with their advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives.

Sample schedules can be found on the BME website (https://www.cmu.edu/bme/Academics/undergraduate-programs/bsip_track.html) page on the BME website.

Cellular and Molecular Biotechnology (CMBT) Track

**Overview**

The CMBT track emphasizes fundamentals and applications of biochemistry, biophysics, and cell biology, and processes on the nanometer to micrometer size scale. Students in this track acquire understanding of the molecular and cellular bases of life processes, and build skills in quantitative modeling of live cell-based biotechnologies and in technologies that exploit the unique properties of biomolecules in non-biological settings.

**Targets**

The CMBT track is ideally suited for the combined education of Biomedical Engineering and Chemical Engineering, which provides a strong core of chemistry and molecular processing principles. The track may also interest students of Mechanical Engineering, Materials Science & Engineering, Civil & Environmental Engineering who have an interest in molecular aspects of Biomedical Engineering. The CMBT track prepares students for careers in bio/pharmaceutical, medical diagnostics, biosensors, drug delivery, and biological aspects of environmental engineering.

**Requirements**

In addition to the Biomedical Engineering core courses, students in the CMBT Track must take the following combination of **three** courses:

- One (1) **Required** CMBT Elective
- Two (2) CMBT Electives (either **Required** or **Additional**)

**CMBT Electives**

Required CMBT Electives (must take at least one of the following)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-620</td>
<td>Engineering Molecular Cell Biology</td>
<td>12</td>
</tr>
<tr>
<td>42-623</td>
<td>Cellular and Molecular Biotechnology</td>
<td>9</td>
</tr>
<tr>
<td>42-624</td>
<td>Biological Transport and Drug Delivery</td>
<td>9</td>
</tr>
<tr>
<td>42-684</td>
<td>Principles of Immunoengineering and Development of Immunotherapy Drugs</td>
<td>9</td>
</tr>
</tbody>
</table>

Additional CMBT Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-320</td>
<td>Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>42/06-622</td>
<td>Bioprocess Design</td>
<td>9</td>
</tr>
<tr>
<td>42-625</td>
<td>Drug Delivery Systems</td>
<td>9</td>
</tr>
<tr>
<td>42-643</td>
<td>Microfluidics</td>
<td>12</td>
</tr>
<tr>
<td>42-645/24-655</td>
<td>Cellular Biomechanics</td>
<td>9</td>
</tr>
<tr>
<td>42-673</td>
<td>Special Topics: Stem Cell Engineering</td>
<td>9</td>
</tr>
<tr>
<td>42-676</td>
<td>Bio-nanotechnology: Principles and Applications</td>
<td>9</td>
</tr>
<tr>
<td>42-x00</td>
<td>BME Research* or 39-500 CIT Honors Research Project* or 42-6XX Clinical Course (Surgery for Engineers/ Precision Medicine/ICU Medicine)</td>
<td>9-12</td>
</tr>
</tbody>
</table>

* The 42-x00 research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 CIT Honors Research Project) must be on a BME topic that is aligned to the track, supervised or co-supervised by a BME faculty member, and conducted for 9 or more units of credit.

Some Special Topics, newly offered or intermittently offered courses may be acceptable as track electives. Students should consult with their advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives.

Sample schedules can be found on the CMBT website (https://www.cmu.edu/bme/Academics/undergraduate-programs/cmbt_track.html) page on the BME website.
Neuroengineering (Neuro) Track

Overview
The Neuroengineering (Neuro) track uses engineering techniques to examine, understand, and apply the properties of complex neural systems. Areas of interest include the research and development of neuroengineering technologies for sensing, interfacing, imaging, and modulating the nervous systems. Examples of applications include brain-computer interfaces for use in paralysis, neural stimulation device design for sensory and motor prostheses and basic science research, and neural recording and imaging devices.

Targets
This track aligns most naturally with a combined education of Biomedical Engineering and Electrical & Computer Engineering, which lays a solid foundation in signal processing principles. This track prepares students for careers in brain-computer interfaces, neural stimulators, and neuroprosthetics.

Requirements
In addition to the Biomedical Engineering core courses, students in the BMEC Track must take the following combination of three courses:

- One (1) Required Neuro Elective
- Two (2) Neuro Electives (either Required or Additional)

Neuro Electives
Required Neuro Electives (must take at least one of the following)
- 42-630 Introduction to Neural Engineering 12
- 42-631 Neural Data Analysis 12
- 42-632 Neural Signal Processing 12

Additional Neuro Electives
- 15-386 Neural Computation 9
- 18-370 Fundamentals of Control 12
- 18-412 Neural Technology: Sensing and Stimulation 12
- 18-416 Nano-Bio-Photonics 12
- 18-460 Optimization 12
- 42-437 Biomedical Optical Imaging 9
- 42-447 Rehabilitation Engineering 9
- 42-689 Introduction to Biomedical Imaging 9
- 42-682 Bioinstrumentation 12
- 42-683 Introduction to Machine Learning for Biomedical Engineers 9
- 42-783 Neural Engineering Laboratory 12
- 42-xxx BME Research* or 39-500 CIT Honors Research Projects or 42-6XX Clinical Course (Surgery for Engineers/Preclinical Medicine/ICU Medicine) 12

* The 42-xxx research project (42-200/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 CIT Honors Research Project) must be on a BME topic that is aligned to the track, supervised or co-supervised by a BME faculty member, and conducted for 9 or more units of credit.

Some Special Topics, newly offered or intermittently offered courses may be acceptable as track electives. Students should consult with their advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives.

Sample schedules can be found on the Neuro (https://www.cmu.edu/bme/Academics/undergraduate-programs/neuro_track.html) page on the BME website.

Self-Designed Biomedical Engineering (SBME) Track
The SBME track is aimed at helping highly motivated students who have a strong sense of career direction that falls beyond the scope of regular Biomedical Engineering tracks. Students are allowed to design the “track” portion of the curriculum in consultation with the faculty. Example themes include medical robotics, embedded medical systems, or computational biomedical engineering.

Requirements
In addition to the Biomedical Engineering core requirements, students must take three elective courses of at least 9 units each. These elective courses must form a coherent theme that is relevant to biomedical engineering. In addition, at least one of the elective courses must be judged by the Biomedical Engineering Undergraduate Affairs Committee to have substantial biological or medical content.

If undergraduate research is part of the SBME track, the project must be on a BME topic that is aligned to the track, supervised or co-supervised by a BME faculty member, and conducted for 9 or more units of credit.

Petition Procedure
2. A SBME track proposal must be submitted electronically to Kristin Kropf (https://engineering.cmu.edu//directory/bios/kropf-kristin.html) at least three weeks prior to Pre-Registration during the spring of the sophomore year. The proposal must include:
   - The three courses of the designed track, including catalog descriptions and when these courses are expected to be taken.
   - A justification of how these courses form a coherent theme relevant to biomedical engineering and why the regular tracks do not relate to the proposed theme
   - Two alternative courses that may substitute for one of the proposed courses, in case the original course is not available.
3. Once approved by the Biomedical Engineering Undergraduate Affairs Committee, the student must sign an agreement listing the theme and the three courses comprising the SBME track.
4. In the event that issues beyond the student’s control, such as course scheduling or cancellation, prevent the student from completing the approved course plan, the student may petition the Biomedical Engineering Undergraduate Affairs Committee to:
   - Substitute a course with another course that fits the approved theme, OR
   - Complete one of the regular tracks (all classes)

Minor in Biomedical Engineering
Kristin Kropf, Undergraduate Program and Alumni Relations Coordinator, Biomedical Engineering
kgauska@andrew.cmu.edu
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 toward the minor.

Students who have questions or are interested in declaring Biomedical Engineering minor should contact Kristin Kropf (https://www.cmu.edu/bme/Academics/undergraduate-programs/minor.html)

Requirements
Minimum units required for minor: 57

- 03-121 Modern Biology 9
- 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:

- 42-xxx xx-000/300/400 Sophomore/Junior/Senior Biomedical Engineering Research Project OR 39-500 CIT Honors Research Project
- 42-6XX Clinical Course (Surgery for Engineers/Preclinical Medicine/ICU Medicine)
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.

Full-Time Faculty

ABBOTT, ROSALYN, Assistant Professor of Biomedical Engineering – Ph.D., University of Vermont, 2011;

BARATI FARIMANI, AMIR, Assistant Professor, Mechanical Engineering and Biomedical Engineering – Ph.D., University of Illinois at Urbana-Champaign, 2015;

BARTH, ALISON L., Professor, Biological Sciences, and Biomedical Engineering – Ph.D., University of California, Berkeley, 1997;

BEHRMANN, MARLENE, George A. and Helen Dunham Cowan Professor of Cognitive Neuroscience Center for the Neural Basis of Cognition and Department of Psychology Professor, Biomedical Engineering – Ph.D., University of Toronto, 1991;

BETTINGER, CHRISTOPHER J., Professor of Biomedical Engineering and Materials Science & Engineering – Ph.D., Massachusetts Institute of Technology, 2008;

BRUCHEZ, MARCEL P., Professor of Biological Sciences, Chemistry, and Biomedical Engineering – Ph.D., University of California, Berkeley, 1999;

CAMPBELL, PHIL G., Research Professor, Institute of Complex Engineering Systems, Biomedical Engineering, Biological Sciences, Materials Science & Engineering – Ph.D., The Pennsylvania State University, 1985;

CHALACHEVA, P. SANG, Assistant Teaching Professor of Biomedical Engineering – Ph.D., University of Southern California, 2014;

CHAMANZAR, MAYSAM, Dr. William D. and Nancy W. Strecker Career Development Associate Professor, Electrical and Computer Engineering, Biomedical Engineering – Ph.D., Georgia Institute of Technology, 2012;

CHASE, STEVEN M., Professor of Biomedical Engineering and Center for the Neural Basis of Cognition – Ph.D., Johns Hopkins University, 2006;

CHOSSET, HOWIE, Professor, Robotics Institute, Biomedical Engineering, and Electrical & Computer Engineering – Ph.D., California Institute of Technology, 1996;

COHEN-KARNI, TZAHIT (ITZHAQ), Associate Professor of Biomedical Engineering and Materials Science & Engineering – Ph.D., Harvard University, 2011;

COOK, KEITH, David Edward Schramm Professor and Head – Ph.D., Northwestern University, 2000;

DANDIN, MARC, Assistant Professor, Electrical & Computer Engineering and Biomedical Engineering – Ph.D., University of Maryland, 2012;

FEDDER, GARY K., Howard M. Wilkoff Professor, Institute for Complex Engineering Systems, Biomedical Engineering, Electrical & Computer Engineering, Robotics Institute – Ph.D., University of California, Berkeley, 1994;

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GITTIS, ARYN, Associate Professor, Biological Sciences, and Biomedical Engineering – Ph.D., University of California, San Diego, 2008;

GROVER, PULKIT, Angel Jordan Associate Professor, Electrical & Computer Engineering, Center for Neural Basis of Cognition, and Biomedical Engineering – Ph.D., University of California, Berkeley, 2010;

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KAINERSTORFER, JANA M., Associate Professor of Biomedical Engineering – Ph.D., University of Vienna, 2010;

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MCCARTHY, MORRIS, Associate Professor, Electrical and Computer Engineering, Biomedical Engineering – Ph.D., University of Pennsylvania, 1979;

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PALKESKO, RACHELLE, Assistant Teaching Professor of Biomedical Engineering – Ph.D., Duquesne University, 2011;

PANAT, RAHUL, Russell V. Trader Associate Professor, Mechanical Engineering, Civil & Environmental Engineering, Materials Science & Engineering, and Biomedical Engineering – Ph.D., University of Illinois at Urbana-Champaign, 2004;

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SMITH, MATTHEW, Associate Professor, Biomedical Engineering and Center for the Neural Basis of Cognition – Ph.D., New York University, 2003;
SYDLIK, STEFANIE, Professor of Chemistry and Biomedical Engineering – Ph.D., Massachusetts Institute of Technology, 2012; TAYLOR, REBECCA, Ph.D. – Associate Professor of Mechanical Engineering and Biomedical Engineering, Stanford University, 2013; TILTON, ROBERT D., Chevron Professor; Professor, Biomedical Engineering and Chemical Engineering – Ph.D., Stanford University, 1991; TRUMBLE, DENNIS, Associate Research Professor, Biomedical Engineering and Center for the Neural Basis of Cognition – Ph.D., Carnegie Mellon University, 2010; TUCKER, CONRAD, Arthur Hamerschlag Career Development Professor of Mechanical Engineering, Biomedical Engineering, Machine Learning, and the Robotics Institute – PhD, MBA, University of Illinois, Urbana-Champaign, 2011; VERSTYSEN, TIMOTHY, Associate Professor, Psychology, Center for the Neural Basis of Cognition and Biomedical Engineering – Ph.D., University of California, Berkeley, 2006; WANG, YU-LI, Mehrabian Professor of Biomedical Engineering – Ph.D., Harvard University, 1980; WASHBURN, NEWELL R., Associate Professor of Biomedical Engineering, Chemistry, and Materials Science & Engineering – Ph.D., University of California, Berkeley, 1998; WAYNE, ELIZABETH, Assistant Professor, Biomedical Engineering and Chemical Engineering – Ph.D., Cornell University, 2015; WEBER, DOUGLAS J, Akhtar and Bhutta Professor, Mechanical Engineering, Neuroscience Institute and Biomedical Engineering – Ph.D., Arizona State University, 2001; WEBSTER-WOOD, VICTORIA, Assistant Professor, Mechanical Engineering and Biomedical Engineering – Ph.D., Case Western Reserve University, 2017; WHITEHEAD, KATHRYN A, Professor of Chemical and Biomedical Engineering – Ph.D., University of California, Santa Barbara, 2007; WOOD, SOSSENA, Assistant Professor of Biomedical Engineering – Ph.D., University of Pittsburgh, 2018; YTTRI, ERIC, Assistant Professor, Biological Sciences, Center for the Neural Basis of Cognition, Biomedical Engineering – Ph.D., Washington University in St Louis, 2011; YU, BYRON, Gerard G. Elia Career Development Professor of Biomedical Engineering and Electrical & Computer Engineering – Ph.D., Stanford University, 2007; YU, KAI, Research Scientist of Biomedical Engineering – Ph.D., University of Minnesota, Minneapolis, 2018; ZAPANTA, CONRAD M., Associate Dean of Undergraduate Studies, College of Engineering and Teaching Professor, Biomedical Engineering, – Ph.D., The Pennsylvania State University, 1997; ZHANG, YONGJIE JESSICA, George Tallman Ladd and Florence Barrett Ladd Professor, Mechanical Engineering and Biomedical Engineering – Ph.D., University of Texas at Austin, 2005; ZHENG, SIYANG, Professor, Biomedical Engineering and Electrical and Computer Engineering – Ph.D., California Institute of Technology, 2007;