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 Engineering, Electrical & Computer Engineering, Environmental 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/undergraduate-programs/curriculum/bme-design-fall-and-spring) 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:

<table>
<thead>
<tr>
<th>Core Courses (all required)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121 Modern Biology- Fall and Spring or 03-151 Honors Modern Biology</td>
<td>9</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>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>
<tr>
<td><strong>Total</strong></td>
<td><strong>66</strong></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 (p. 1))
- Biomechanics (BMEC (p. 2))
- Biomedical Devices (BMDV (p. 2))
- Biomedical Signal and Image Processing (BSIP (p. 3))
- Cellular and Molecular Biotechnology (CMBT (p. 3))
- Neuroengineering (Neuro (p. 3))
- Self-Designed Biomedical Engineering (SBME (p. 4))

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 Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-611</td>
<td>Biomaterials</td>
<td>12</td>
</tr>
<tr>
<td>42-612/27-520</td>
<td>Tissue Engineering</td>
<td>12</td>
</tr>
<tr>
<td>42-615</td>
<td>Biomaterial Host Interactions in Regenerative Medicine</td>
<td>12</td>
</tr>
<tr>
<td>42-667</td>
<td>Biofabrication and Bioprinting</td>
<td>12</td>
</tr>
</tbody>
</table>
Additional BMTE Electives

42-613 Polymeric Biomaterials 12
42-616 Bio-nanotechnology: Principles and Applications 9
42-620 Engineering Molecular Cell Biology 12
42-624 Biological Transport and Drug Delivery 9
03-320 Cell Biology 9
42-x00 BM Research* or 39-500 CIT Honors Research Project* or 42-6XX Clinical Course (Surgery for Engineers/Precision Medicine/CU Medicine) 9-12

* 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 track electives. Students should consult with their BME advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives. The course petition form can be found here (https://www.cmu.edu/bme/Academics/undergraduate-programs/advising.html#ug-course-petition).

Sample schedules can be found on the BME Additional Major (https://www.cmu.edu/bme/Academics/undergraduate-programs/major.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)

42-649 Introduction to Biomechanics 12
42-648 Cardiovascular Mechanics 12
42-645/24-655 Cellular Biomechanics 9
42-691 Biomechanics of Human Movement 12

Additional BMEC Electives

42-641 Rehabilitation Engineering 9
42-640/24-658 Image-Based Computational Modeling and Analysis 12
42-444 Medical Devices 9
16-868 Biomechanics & Motor Control 12
16-879 Medical Robotics 12
42-x00 BM Research* or 39-500 CIT Honors Research Project* or 42-6XX Clinical Course (Surgery for Engineers/Precision Medicine/CU Medicine) 9-12

* 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 track electives. Students should consult with their BME advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives. The course

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)

42-660 Biomedical Instrumentation 12
42-678 Medical Device Innovation and Realization 12
42-693 Special Topics in Integrated Systems Technology: Micro/Nano Biomedical Devices 12
42-694 Engineering Principles of Medical Devices 9

Additional BMDV Electives

42-444 Medical Devices 9
42-611 Biomaterials 12
42-616 Bio-nanotechnology: Principles and Applications 9
42-630 Introduction to Neural Engineering 12
42-641 Rehabilitation Engineering 9
42-648 Cardiovascular Mechanics 12
42-650 Introduction to Biomedical Imaging 9
42-652/18-416 Nano-Bio-Photronics 12
42-675 Fundamentals of Computational Biomedical Engineering 12
16-467 Human Robot Interaction 12
16-879 Medical Robotics 12
18-412 Neural Technology: Sensing and Stimulation 12
42-6XX Clinical Course (Surgery for Engineers/Precision Medicine/CU Medicine) 9
42-x00 BM Research* or 39-500 CIT Honors Thesis 9

* 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 track electives. Students should consult with their BME advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives. The course...
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, or 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>42-621</td>
<td>Principles of Immunoengineering and Development of Immunotherapy Drugs</td>
<td>9</td>
</tr>
<tr>
<td>42-624</td>
<td>Biological Transport and Drug Delivery</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>42-616</td>
<td>Bio-nanotechnology: Principles and Applications</td>
<td>9</td>
</tr>
<tr>
<td>42-626</td>
<td>Drug Delivery Systems</td>
<td>9</td>
</tr>
<tr>
<td>42-645/24-655</td>
<td>Cellular Biomechanics</td>
<td>9</td>
</tr>
<tr>
<td>03-320</td>
<td>Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>06-722</td>
<td>Bioprocess Design</td>
<td>12</td>
</tr>
<tr>
<td>42-x00</td>
<td>SME Researchor 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 track electives. Students should consult with their BME advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives. The course petition form can be found here (https://www.cmu.edu/bme/Academics/undergraduate-programs/advising.html#ug-course-petition). Sample schedules can be found on the BME Additional Major (https://www.cmu.edu/bme/Academics/undergraduate-programs/major.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.

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>42-650</td>
<td>Introduction to Biomedical Imaging</td>
<td>9</td>
</tr>
<tr>
<td>42-668</td>
<td>Fundamentals of MRI and Neuroimaging Analysis</td>
<td>9</td>
</tr>
<tr>
<td>42-631</td>
<td>Neural Data Analysis</td>
<td>12</td>
</tr>
<tr>
<td>42-622</td>
<td>Neural Signal Processing</td>
<td>12</td>
</tr>
</tbody>
</table>

Additional BSIP Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-437</td>
<td>Biomedical Optical Imaging</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>42-625</td>
<td>Introduction to Machine Learning for Biomedical Engineers</td>
<td>9</td>
</tr>
<tr>
<td>42-660</td>
<td>Bioinstrumentation</td>
<td>12</td>
</tr>
<tr>
<td>42-675</td>
<td>Fundamentals of Computational Biomedical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>16-725</td>
<td>(Bio)Medical Image Analysis</td>
<td>12</td>
</tr>
<tr>
<td>18-491</td>
<td>Digital Signal Processing</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>

1 Students make take either 18-491 Fundamentals of Signal Processing OR 18-792 Advanced Digital Signal Processing (but not both)

* 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 track electives. Students should consult with their BME advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives. The course petition form can be found here (https://www.cmu.edu/bme/Academics/undergraduate-programs/advising.html#ug-course-petition). Sample schedules can be found on the BME Additional Major (https://www.cmu.edu/bme/Academics/undergraduate-programs/major.html) page on the BME website.
**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 at least one of the following 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)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-630</td>
<td>Introduction to Neural Engineering</td>
<td>12</td>
</tr>
<tr>
<td>42-631</td>
<td>Neural Data Analysis</td>
<td>12</td>
</tr>
<tr>
<td>42-632</td>
<td>Neural Signal Processing</td>
<td>12</td>
</tr>
</tbody>
</table>

**Additional Neuro Electives**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-437</td>
<td>Biomedical Optical Imaging</td>
<td>9</td>
</tr>
<tr>
<td>42-641</td>
<td>Rehabilitation Engineering</td>
<td>9</td>
</tr>
<tr>
<td>42-650</td>
<td>Introduction to Biomedical Imaging</td>
<td>9</td>
</tr>
<tr>
<td>42-652/416</td>
<td>Nano-Bio-Photonics</td>
<td>12</td>
</tr>
<tr>
<td>42-656</td>
<td>Introduction to Machine Learning for Biomedical</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Engineers</td>
<td></td>
</tr>
<tr>
<td>42-660</td>
<td>Bioinstrumentation</td>
<td>12</td>
</tr>
<tr>
<td>42-783</td>
<td>Neurological Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>15-386</td>
<td>Neural Computation</td>
<td>9</td>
</tr>
<tr>
<td>18-370</td>
<td>Fundamentals of Control</td>
<td>12</td>
</tr>
<tr>
<td>18-412</td>
<td>Neural Technology: Sensing and Stimulation</td>
<td>12</td>
</tr>
<tr>
<td>18-460</td>
<td>Optimization</td>
<td>12</td>
</tr>
<tr>
<td>42-x00</td>
<td>BME Research* or 39-500 CIT Honors Research</td>
<td>9-12</td>
</tr>
<tr>
<td></td>
<td>Project* or 42-6XX Clinical Course (Surgery for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engineers/Precision Medicine/ICU Medicine)</td>
<td></td>
</tr>
</tbody>
</table>

* The 42-x00 research project (42-200/300/400 Sophomore/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 track electives. Students should consult with their BME advisors and petition the BME Undergraduate Affairs Committee for permission to include such courses as track electives. The course petition form can be found here (https://www.cm.edu/bme/Academics/undergraduate-programs/advising.html#ug-course-petition).

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

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**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 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.

**Petition Procedure**

1. Students wishing to pursue a self-designed track should first consult with Kristin Kropf (https://engineering.cmu.edu/directory/bios/kropf-kristin.html) (Undergraduate Program and Alumni Relations Coordinator).

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 courses)

**Minor in Biomedical Engineering**

Kristin Kropf, Undergraduate Program and Alumni Relations Coordinator, Biomedical Engineering

Email: kgaluska@andrew.cmu.edu

https://www.cm.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 (kgaluska@andrew.cmu.edu).

**Requirements**

**Minimum units required for minor: 57**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</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>
<td></td>
</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>9-12</td>
</tr>
<tr>
<td>42-xxx</td>
<td>BME Elective II</td>
<td>9-12</td>
</tr>
<tr>
<td>42-xxx</td>
<td>BME Elective III</td>
<td>9-12</td>
</tr>
</tbody>
</table>

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 counted 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
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 at Berkeley, 1997;
BETTINGER, CHRISTOPHER J., Professor of Biomedical Engineering and Materials Science & Engineering – Ph.D., Massachusetts Institute of Technology, 2008;
CAMPBELL, PHIL G., Research Professor, Biomedical Engineering, Engineering Research Accelerator, Biological Sciences, and Materials Science & Engineering – Ph.D., The Pennsylvania State University, 1985;
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