

# BIOMEDICAL ENGINEERING

## Degree Requirements

### Master of Science (M.S.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (<http://gradschool.psu.edu/graduate-education-policies/>)

A minimum of 30 credits at the 400, 500, 600, or 800 level is required, with at least 24 credits in BME/BIOE at the 500 or 800 level. Students choosing to complete a scholarly paper must complete at least 32 credits, with 18 credits in 500-level courses. Students choosing to complete a thesis must complete a minimum of 30 credits with at least 24 credits at the 500, 600, or 800-level. Students choosing to complete a thesis must also complete at least 6 credits in thesis research (600 or 610).

### Non-Thesis (Scholarly Paper) Track

Students choosing to complete a scholarly paper must take the following:

Code	Title	Credits
<b>Required Courses</b>		
9 credits of foundation courses at the BIOE 500-level		9
12 credits of fundamentals and/or applications courses (with a minimum of 3 credits from each category)		12
BIOE 591	Bioengineering Ethics and Professional Development	1
BIOE 590	Colloquium (two 1-credit graduate seminars)	2
BME 429	Biomedical Mechanics and Techniques Laboratory	2
<b>Culminating Experience</b>		
BME 594	Research Topics	6
<b>Total Credits</b>		<b>32</b>

To complete the degree in one year, students are required to take at least one credit of research for each of the three semesters (Fall, Spring, and Summer). A research adviser must be assigned to students in their first semester, as selection and discussion of the student's research topic must begin as soon as possible. Students who need more time to complete the final paper must be allowed to complete the paper, and have it reviewed and approved after the third semester (Summer) has ended. Students are not required to remain in residence while they complete the final paper. However, extensions granted to students in this program must comply with the Graduate Council policy on deferred grades (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-400/gcac-401-grading-system/>).

**Mentored Projects:** By the end of September, a student will identify an adviser. A mentored project assigned by the adviser will be completed and a culminating project using the data as a basis for the scholarly paper will be submitted and evaluated. These projects are completed while enrolled in BME 594.

### Thesis Track

For students choosing to complete a thesis, upon entering the program, the student, along with their research adviser, will select an academic advisory committee. Working with this committee, the student will select courses appropriate to their research and their professional goals.

Course expectations are set up so that course work during the semester will require up to half of the students' time with research activities taking

up the majority of the time. Summers are generally set aside for full-time research. Beyond the specific course requirements listed below, M.S. students are expected to publish at least one first-author paper based on their research. This is not a requirement for graduation, however.

Students choosing to complete a thesis must take the following:

Code	Title	Credits
<b>Required Courses</b>		
12 credits of lecture- or laboratory-based coursework at the 500-level <sup>1</sup>		12
6 credits of lecture- or laboratory-based coursework at the 400- or 500-level <sup>1</sup>		6
BIOE 591	Bioengineering Ethics and Professional Development	1
1-credit graduate seminar for every semester in attendance		4
<b>Electives<sup>2</sup></b>		<b>1</b>
<b>Culminating Experience</b>		
BIOE 600	Thesis Research	6
<b>Total Credits</b>		<b>30</b>

<sup>1</sup> Course work must include at least 6 credits each in bioengineering, life sciences, and technical/quantitative electives.

<sup>2</sup> Students will select additional course work and research credits from a list of approved electives maintained by the program office, as appropriate, to obtain the total minimum of 30 credits.

The thesis must be accepted by the advisers and/or committee members, the head of the graduate program, and the Graduate School, and the student must pass a thesis defense.

### Doctor of Philosophy (Ph.D.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (<http://gradschool.psu.edu/graduate-education-policies/>)

Upon entering the Ph.D. program, the student will be assigned an academic advisory committee, consisting of three members of the Biomedical Engineering Graduate Faculty (including the adviser). Working with this committee, the student will select courses appropriate to their research and professional goals.

The minimum credit requirements for a Ph.D. in Biomedical Engineering are as follows:

Code	Title	Credits
<b>Required Courses</b>		
6 credits each in Biomedical Engineering, life sciences, and technical/quantitative electives		6
12 credits that are lecture- or laboratory-based (not independent study) and at the 500-level		12
6 credits at the 500-level in courses relevant to their research		6
4 credits in graduate program seminar series (1 credit every semester until passing the comprehensive exam)		4
BIOE 591	Bioengineering Ethics and Professional Development	1
<b>Total Credits</b>		<b>29</b>

600-level research credits are assigned every semester in attendance. Graduate credits earned at other institutions, including those used toward

a degree, may be used to satisfy some of the Ph.D. degree requirements at Penn State, but in these cases, credits are not transferred. Regardless of previous courses taken, every doctoral student must take a minimum of 6 credits at the 500-level at the University Park campus.

Supporting courses are available at University Park in: anatomy, biochemistry, biology, biophysics, chemistry, laboratory animal medicine, materials science, mathematics, physics, physiology, and the engineering departments.

Students who enter the Ph.D. program with a master's degree will work with their Ph.D. committee to determine the suitability of substitutions for courses already taken.

### **Exams**

The Qualifying Exam is the first of three formal exams required for a Ph.D. The exam is taken at the end of the first year of study, typically during the summer following Spring semester. The exam is also given at the end of Fall semester. The purpose of the Qualifying Exam is to ensure that students possess the qualifications expected of a Ph.D. student and have the potential to perform at the high level expected of a Ph.D. biomedical engineer upon completion of the degree. The format of the exam is a written proposal on a research topic different from the student's dissertation project, followed by an oral defense.

The next step toward the Ph.D. degree is the comprehensive exam, which is given when the student has completed all required course work. The comprehensive exam is generally given between the end of the second year and the end of the third year of the Ph.D. program and must take place at least one year prior to the Ph.D. dissertation defense (final oral examination). The exam is intended to evaluate the student's mastery of the major (and if appropriate, minor) field. The Biomedical Engineering Program uses the comprehensive exam as an opportunity to evaluate the Ph.D. student's dissertation proposal. In preparation for the exam, the student must have formed a Ph.D. committee, scheduled an exam time, and prepared a detailed Ph.D. dissertation proposal according to departmental guidelines.

Ph.D. students must have satisfied the English competence and the communication requirement before scheduling the comprehensive exam. This requirement is fulfilled during the oral Qualifying Exam. The Ph.D. committee must meet all Graduate Council requirements (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-602-phd-committee-formation/>).

The doctoral candidate who has satisfied all other requirements for the degree will be scheduled to take the final oral examination. According to Biomedical Engineering Program policy, the final oral exam may not be scheduled until at least one year after the comprehensive exam was passed. Every Ph.D. student must meet with their Ph.D. Committee. This meeting is to preview the dissertation structure with the committee and to ensure that the student, adviser, and committee all agree on expectations for the dissertation and defense.

To earn the Ph.D. degree, doctoral candidates must write a dissertation that is accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School, and the student must pass a final oral examination (the dissertation defense).