

Biomedical Engineering

Degrees Offered

- Masters of Science in Biomedical Engineering (M.S.Bm.E.)
- Doctor of Philosophy, Biomedical Engineering (Ph.D.)

The focus of the graduate program will be to prepare students to be skilled in learning and discovering of processes that aim to integrate engineering and life sciences for the advancement of human health and medical technologies. Just as importantly, the program will build upon current collaborative efforts with local and regional clinicians, industry and academic leaders engaged in state-of-the-art biomedical engineering research. Lastly, the program will foster the production and application of new knowledge in areas that impacts the health and well-being of all West Virginia (WV) citizens, as well as contribute to the providing skilled local workers in BMEG thus driving development of the WV's economy in this exciting area.

Student Learning Outcomes

The learning outcomes of students graduating in BMEG will be defined and measured as follows:

1. Mastery of basic and advanced graduate level knowledge in their chosen areas of specialty as related to BMEG. This outcome will be measured through the grades that the students earn in their coursework;
2. Ability to complete on time specific research tasks. This outcome will be measured through the grade (Satisfactory, Incomplete, or Unsatisfactory) that the student receives every semester from his/her major research advisor for the appropriate research course (700 level);
3. Strong oral communication skills. This outcome will be measured through the quality and number of oral presentations and reports given by the student to his/her Advising and Examining Committee (AEC), at technical meetings or conferences, as well as meetings of his/her research team;
4. Strong communication skills in writing. This outcome will be measured through the quality and number of technical reports, articles or reviews that the student may write during his/her graduate studies. Additionally, the quality of student's communication skills in writing will be measured through the dissertation;
5. Ability to work independently in a collaborative environment – This outcome will be measured through feedback solicited from the members of student's AEC, his/her peers, as well as the length of time the student needs to complete his/her graduate studies.

Admissions and Performance Standards

Students applying for admission to the graduate program in BMEG must meet the general requirements of admission of the WVU graduate school. Admission is expected to be competitive and students will be selected on the basis of their scholastic preparation and intellectual capacity as demonstrated in the application. Further, in addition to the university requirements, the CBE department where the student is to be enrolled will request the following proofs as part of the application:

- Applicant has a bachelor's degree from a recognized 4-year university, in engineering, or engineering-related disciplines including life science, physical science, computer science, biological science, physics, chemistry, mathematics, or applied mathematics;
- Applicants have a minimum 3.0/4.0 grade point average overall, in the last 2 years of undergraduate study, and in their major field;
- Applicants should have the General Graduate Record Examination (GRE); non-official report acceptable for admissions review;
- Strong quantitative skills and background in life sciences, as evidenced by coursework or research experience should be demonstrated;
- Transcripts from all the universities attended. Applicants are required to upload the academic records from each academic institution (undergraduate and/or graduate) attended. Official, original academic credentials that are issued in a language other than English must be accompanied by a certified English translation. These however will be considered unofficial copies;
- Test of English as a Foreign Language (TOEFL) for all non-native-English-speaking students regardless of previous education in English-speaking institutions. A minimum score of 79 (550 on the old (paper-based) scoring scale) is required. Specifically, applicants whose native language is not English must score at least 550 on the paper and pencil TOEFL, 213 on the computer-based TOEFL, or 79 on the internet-based TOEFL, or receive an overall band score of 6.5 on the International English Testing System (IELTS) examination to be considered for admission;
- Three letters of recommendation, submitted online directly by the referees;
- Student CV;
- Statement of purpose, as part of the online application; this should not be more than two pages. The Statement of purpose should describe the motivation for graduate study and how it relates to their professional goals, area of research interest, as well as the potential supervising professor (if identified). The student should also identify the primary areas of research interests and the most likely BMEG faculty member the applicant would like to work with. The applicant could also indicate up to 3 areas of research interests as appropriate from the research directions in the CBE and at WVU respectively. Students are encouraged to directly contact faculty about research opportunities and their willingness to serve as their supervising professor.
- Non-refundable fee of US 60.00 \$.

Curriculum in Master of Science in Biomedical Engineering

A candidate for the M.S. degree in biomedical engineering must comply with the rules and regulations as outlined in the WVU Graduate Catalog and the specific requirements of the Statler College and the Chemical Engineering Department.

Program Requirements

All M.S. degree candidates are required to perform research and follow a planned program of study. The student's research advisor, in conjunction with the student's Advising and Examining Committee (AEC) will be responsible for determining the plan of study appropriate to the student's needs. The underlying principle of the planned program is to provide the students with the necessary support to complete their degree and prepare them for their career.

Curriculum Requirements

A minimum GPA of 3.0 is required in all courses

A minimum of 60% of courses must be from 500 level or above

A grade of C- or higher must be earned in all required courses

BMEG 501	Principles and Applications of Biomedical Engineering	3
BMEG 601	Numerical and Statistical Methods for Biomedical Engineering	3
BMEG 602	Interfacial Phenomena in Living and Non-Living Systems	3
Advisor Approved Coursework *		14
CHE 694	Seminar	1
CHE 697	Research	6
Total Hours		30

* All elective courses must be approved by the Statler College Graduate Admissions and Curriculum Committee and student's AEC.

Curriculum in Doctor of Philosophy – Biomedical Engineering

A candidate for the Ph.D. degree with a major in biomedical engineering must comply with the rules and regulations as outlined in the WVU Graduate Catalog and the specific requirements of the Statler College and the Chemical Engineering Department.

Program Requirements

The doctor of philosophy degree with a major in biomedical engineering is administered through the college's interdisciplinary Ph.D. program. The research work for the doctoral dissertation must show a high degree of originality on the part of the student and must constitute an original contribution to the art and science of chemical engineering.

All Ph.D. degree candidates are required to perform research and follow a planned program of study. The student's research advisor, in conjunction with the student's Advising and Examining Committee (AEC) will be responsible for determining the plan of study appropriate to the student's needs. The underlying principle of the planned program is to provide the students with the necessary support to complete their degree and prepare them for their career.

The College requires Ph.D. programs to have a minimum of 18 semester hours of course work, beyond the course credit required for a master's degree, at the 500 and higher levels with an average of 3.0 or better. The faculty of the college believes that the experience gained in performing and reporting a research endeavor should be over a prolonged period. Therefore, a significant portion of doctoral credit is research based. Specifically, beside the accumulation of a minimum of 18 credit hours of coursework taken at WVU, there are also required 2 credit hours of seminar and a minimum of 24 credit hours of research, also taken at WVU. The remaining requirements for this graduate degree are as follows: (1) passing the qualifying examination, (2) admission to candidacy, (3) completion of dissertation research, and (4) defense of a research dissertation; these requirements are well detailed below. Briefly:

- The student should form a 5 member AEC and file a draft plan of study by the end of their 2nd semester of enrollment in the graduate program. At least one member of the graduate faculty from outside the student's home Department is required to serve on the AEC;
- The student's research advisor, in conjunction with the student's AEC will be responsible for determining the plan of study appropriate to the student's interests/needs. The underlying principle of the planned program is to provide the students with the necessary support to complete their degree and prepare them for their future career in BMEG-related areas;
- All students pursuing a Ph.D. degree are expected to engage in research and complete and successfully defend a Ph.D. dissertation. The doctoral dissertation must show a high degree of originality, i.e. be an original contribution to BMEG-related areas;
- The integrity of the research conduct is the utmost importance to the institution and our department. We are committed to promoting and supporting the ethical and responsible conduct of research across all disciplines. As a result, all students are required to take an online RCR training in their first year;

- The Ph.D. degree signifies that the holder has the competence to function independently at the highest level in the chosen field. Hence, the number of years involved in attaining or retaining competency cannot be readily specified, nor can the exact program of study be defined. However, one has a maximum of 5 years to complete all the requirements for Ph.D. from the date of admission to candidacy.

Curriculum Requirements

A minimum GPA of 3.0 is required in all courses

A minimum of 60% of courses must be from 500 level or above

A grade of C- or higher must be earned in all required courses

BMEG 501	Principles and Applications of Biomedical Engineering	3
BMEG 601	Numerical and Statistical Methods for Biomedical Engineering	3
BMEG 602	Interfacial Phenomena in Living and Non-Living Systems	3
Advisor Approved Coursework *		18
CHE 694	Seminar	2
Research		24
CHE 697	Research	

Examinations

Qualifying Examination

Candidacy Examination

Final Examination

Total Hours 53

* All elective courses must be approved by the Statler College Graduate Admissions and Curriculum Committee and student's AEC.

Examinations

QUALIFYING EXAMINATION

All Ph.D. students must pass a Ph.D. qualifying examination. This examination is designed to assess the basic competency in BMEG-related fields and determine whether or not students have sufficient knowledge to undertake independent research. Students are required to pass such qualifying examination by the end of their 2nd semester of enrollment in the program; however, it is normally required that full-time students pass the qualifying examination no later than the end of the 3rd semester of enrollment.

The structure of the Ph.D. qualifying examination for all students pursuing the Ph.D. degree in BMEG will be comprised of two components: a written examination that will test on the student's knowledge in the 3 core areas studied in BMEG 501, Principles and Applications of Biomedical Engineering, BMEG 601 Numerical and Statistical Methods for Biomedical Engineering and BMEG 602 Interfacial phenomena in living and non-living systems respectively, or their equivalent. Students who do not pass this examination on their initial attempt will be allowed a 2nd attempt which should be scheduled in the follow up semester. If they are not successful on their 2nd attempt, then they will be dismissed from the program.

CANDIDACY EXAMINATION

In order to be admitted to candidacy, the student must pass a candidacy exam, which is designed to evaluate student's overall ability to engage in high-level research. Admission to candidacy can be assessed by a dissertation proposal and/or additional examination. Within a maximum of one semester after passing the PhD qualifying examination or entering the Ph.D. program, whichever is later, a student must successfully defend his/her dissertation research proposal. This proposal is a written document which must be reviewed and accepted by their AEC and subsequently defended in an oral presentation; the proposed research work should show a high degree of originality in the field. A student who has successfully completed all coursework, passed the qualifying examination, and successfully defended the research proposal is defined as one who is a candidate for the Ph.D. degree in BMEG at WVU.

Doctoral candidates are allowed no more than 5 years to complete the remaining degree requirements after formal admission to candidacy. An extension of time can be obtained only by repeating the qualifying and candidacy examinations and meeting any other requirements specified by the student's advisory and examining committee.

FINAL EXAMINATION

At the completion of the dissertation research, candidates must prepare a dissertation and pass the final oral examination (defense) administered by their AEC. Candidates should be demonstrating an original contribution to scientific knowledge and engineering practice in BMEG. The defense examination is open to the public and, in order to evaluate critically the student's competency, may include testing on material in related fields, as deemed necessary by the AEC. In addition, since the Ph.D. degree is primarily a research degree that embodies the results of an original research proposal and represents a significant contribution to scientific literature, the student must submit a manuscript on this research to the AEC. The rules

for this defense and the timing for the manuscript submission are specified by the Office of Graduate Studies at WVU and the Statler College; neither a foreign language nor a minor is required for the Ph.D.

Major Learning Outcomes

BIOMEDICAL ENGINEERING

Student Learning Outcomes

The learning outcomes of students graduating in BMEG will be defined and measured as follows:

1. Mastery of basic and advanced graduate level knowledge in their chosen areas of specialty as related to BMEG. This outcome will be measured through the grades that the students earn in their coursework;
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COURSES

BMEG 501. Principles and Applications of Biomedical Engineering. 3 Hours.

PR: Consent. Introduction to the principles of biomedical engineering from cells to systems. Biomedical engineering concepts and applications as related to biomaterials, drug delivery, tissue engineering, biohybrid devices, bioinstrumentation, bioimaging, and other areas. Emphasis on critical thinking and development of original research ideas.

BMEG 593A. Special Topics. 1-6 Hours.

A study of contemporary topics selected from recent developments in the field.

BMEG 601. Numerical and Statistical Methods for Biomedical Engineering. 3 Hours.

PR: Consent. Introduces analysis methods for research in biomedical engineering. Topics include numerical analysis, simulation of dynamic systems, statistical inference test and applications in clinical trials, time-series data analysis, machine learning, bioimaging, and acquiring physiological data. Through homework projects, relevant examples and extensive case studies, this course will equip students with the tools to conduct research in biomedical engineering.

BMEG 602. Interfacial Phenomena in Living and Non-Living Systems. 3 Hours.

PR: Consent. Introduces concepts related to the interfacial phenomena in living and non-living systems. Specific topics covered include the free energy of interface formation, intermolecular and surface forces, energetic processes, thermodynamics, statistical mechanics, and interfacial phenomena that emphasize the chemical natures of living and non-living systems.