

Doctor of Philosophy Engineering with a Concentration in Biomedical Engineering (PhD)

Web Site: <https://www.odu.edu/biomedical-engineering> (<https://www.odu.edu/biomedical-engineering/>)

Biomedical Engineering Program

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The Biomedical Engineering graduate degree programs are available to full-time and part-time students seeking to improve their research and professional skills in biomedical engineering. The programs strive to provide the highest quality engineering education at the graduate level, to engage in scholarly research at the forefront of biomedical engineering, and to serve the profession of biomedical engineering. While the biomedical engineering program is administered by the Department of Electrical & Computer Engineering, the program is highly interdisciplinary and students are admitted from broad areas of engineering, science, and healthcare. Cutting-edge research opportunities and instruction are offered in:

- Bioelectrics and Pulsed Power
- Cellular & Molecular Bioengineering
- Cardiovascular Engineering
- Musculoskeletal Biomechanics
- Plasma Medicine
- Systems Biology & Computational Bioengineering

Facilities: The Biomachina Laboratory; the Biomechanics Laboratory; Biomedical Devices and Biomanufacturing Lab; the Cellular Mechanobiology Laboratory; the Machine Intelligence & HR Communications Lab; the Gene Therapy and Regenerative Medicine Laboratory; the Medical Simulations Laboratory; the Medical Simulations Lab; and the Virginia Institute for Imaging and Vision Analysis (VIIVA).

The program also has strong ties to several other on- and off-campus laboratories, including the Applied Research Center at the Jefferson National Laboratory, the Center for Brain Research and Rehabilitation, the Frank Reidy Research Center for Bioelectrics, Center for Bioelectronics, and the Virginia Modeling, Analysis and Simulation Center (VMASC). Regional, national, and international clinical collaborators support the program. These unique resources position the biomedical engineering program as a leader in education and research in the Southeast and nationally.

Doctor of Philosophy Admission Requirements

Admission to the Ph.D. program in biomedical engineering is in accordance with Old Dominion University and Frank Batten College of Engineering and Technology requirements for doctoral programs as specified in this catalog. Specific additional requirements include the following:

1. Completion of a master's degree in a closely related field is expected. Accepted students from disciplines other than Biomedical Engineering will be required to complete a number of leveling courses to meet the prerequisites of the program; the Graduate Program Director will work with the admitted students to create the list of leveling courses, including calculus and differential equations.

2. A minimum GPA of 3.50 (out of 4.0) is required of most students. A student with a lower GPA meeting ODU's graduate admission requirements and with evidence of a high level of professional capability may be eligible for admission to the program upon submission of a petition to the graduate program director.
3. Recent scores, typically, not more than five years old, on the Graduate Record Examination's (GRE) verbal, quantitative, and analytical writing sections must be submitted by all applicants.
4. Three letters of recommendation (typically at least two of which are from faculty in the highest degree program completed when the application is within five years of graduation from that degree program) are encouraged but not required.
5. The applicant must submit a resume and a statement of purpose and goals.
6. Foundation knowledge in physics, basic chemistry, physiology, computer programming, and mathematics (including differential equations and statistics) is expected. Some leveling courses may be required to complement the student's expertise, namely in physiology, statistics, and differential equations.
7. The Frank Batten College of Engineering and Technology at Old Dominion University has the Direct Bachelor-to-Ph.D. and linked Bachelor/Ph.D. programs that allow exceptionally well-qualified undergraduate students to apply for admission directly to a Ph.D. program. Typically, undergraduate students apply at the end of their junior year for admission to the linked programs.

Curriculum Requirements

The Ph.D. degree requires:

- 24 credit hours of graduate-level courses beyond the master's degree,
- 24 research credit hours (BME 899) beyond the master's degree,
- successful completion of a written diagnostic examination,
- successful completion of written and oral candidacy examinations,
- successful completion of a dissertation research proposal, and
- successful completion and public defense of a dissertation.
- Or, in the absence of a master's degree, 78 credit hours beyond the bachelor's degree are required.

The program of study will be developed with the approval of the graduate program director and the student's advisor. The 24-credit course program shall include a common core of 12 credits (four 3-credit courses) including : BME 811 Biological Mechanisms for Biomedical Engineers, BME 812 Engineering Fundamentals in Biomedicine, BME 840 Regenerative Medicine, and BME 847 Responsible Conduct of Research (now worth 3CH). 12 credits of elective coursework are also required and are described below.

For students without a master's degree, a total of 78 credit hours of graduate level coursework is required, consisting of 48 credit hours of graduate courses (the 24 course credits listed above for master's holders, plus 24 elective credits), as well as 30 research credit hours (BME 899). Three fifths of the required 48 course credit hours must be at the 800 level and need to comply with regular PhD program degree requirements.

Exceptions to the credit-hour distribution requirements at any level must be approved in writing by the graduate program director, the dean or his or her designee, and the provost or his or her designee. Additional course work or appropriate research background may be required to meet prerequisites for courses or in preparation for the diagnostic examination.

BME Common Core 12

Complete the following Core courses (12 credits):

BME 811	Biological Mechanisms for Biomedical Engineers
BME 812	Engineering Fundamentals in Biomedicine
BME 840	Regenerative Medicine
BME 847	Responsible Conduct of Research

BME Technical Electives¹ 6

1 Engineering with a Concentration in Biomedical Engineering (PhD)

Complete 6 credits of coursework from the following:

BME 530	Therapy and Function Models for Medical Simulation
BME 554	Introduction to Bioelectronics
BME 562	Introduction to Medical Image Analysis
BME 564	Biomedical Applications of Low Temperature Plasmas
BME 612	Digital Signal Processing I
BME 800	Cardiovascular Physiology
BME 802	Biomedical Sciences Journal Club
BME 810	Advanced Cell Biology
BME 814	Biomedical Sciences Laboratory
BME 820	Modern Biomedical Instrumentation
BME 821	Mathematical Modeling in Physiology
BME 826	Biomaterials
BME 830	Predoctoral Fellowship Grant Writing
BME 831	Finite Element Analysis
BME 841	Principles of Visualization
BME 851	Computational and Statistical Methods in Biomedical Engineering
BME 854	Advanced Bioelectronics
BME 855	Biomembranes and Ion Channels
BME 860	Autonomous and Robotic Systems Analysis and Control
BME 862	Applied Medical Image Analysis
BME 870	Advanced Study in Biology
BME 875	Grant Writing in Biology
BME 883	Digital Image Processing
BME 885	Advanced Manufacturing Technology
BME 892	Biomechanics
BME 894	Cellular Biomechanics
BME 895	Special Topics in Biomedical Engineering
BME 897	Independent Study
BME 999	Doctoral Graduate Credit

Approved Technical Electives¹ 6

Complete 6 credits of coursework from electives not necessarily listed above.

Dissertation Research 24

BME 899	PHD Dissertation Research
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Total Credit Hours 48

¹ The technical elective courses provide a basis for dissertation research and future career objectives. These courses can be selected from the biomedical engineering technical electives (6 credits) or a wide variety of appropriate graduate courses (6 credits) in engineering, biology, chemistry, psychology, computer science, modeling and simulation, mathematics, statistics, or other programs. At least 15 credits of non-dissertation course work must be at the 800-level. A minimum of 3 credits must be selected from the biomedical engineering technical electives list; the remaining credits can be selected from this list or other graduate courses with approval of the student's advisor and the graduate program director.

1. Completion of a minimum of 48 hours of graduate credits to include: a minimum of 24 credits of course work beyond the master's degree and a minimum of 24 credits of dissertation research. At least 15 credits of non-dissertation course work must be at the 800-level. The Graduate Program Director in concurrence with the Chair can approve exceptions to these requirements under special circumstances.
2. For students without a master's degree, a total of 78 credit hours of graduate level coursework is required, consisting of 48 credit hours of graduate courses (the 24 course credits listed above for master's holders, plus 24 elective credits), as well as 30 research credit hours (BME 899). Three fifths of the required 48 course credit hours must be at the 800 level and need to comply with regular PhD program degree requirements.
3. Successful completion of a written diagnostic examination before the end of the first academic year.
4. Successful completion of a written and oral qualifying examination near the completion of the coursework.
5. Successful presentation of a dissertation research proposal at the beginning of the dissertation research.
6. The successful completion and public defense of a dissertation representing independent, original research worthy of publication in a peer-reviewed scholarly journal. At least one published and one submitted manuscript as first author in peer-reviewed, indexed journals are expected.

Doctor of Philosophy Degree Requirements

The Ph.D. in biomedical engineering is offered in accordance with the general requirements for doctoral degrees as specified in the Requirements for Graduate Degree Section of this catalog. Specific program of study requirements include the following: