MASTER OF SCIENCE IN BIOENGINEERING

Master of Science in Bioengineering

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Program Features

Wilkes University’s Master of Science degree in Bioengineering combines engineering concepts and analysis with biology, medicine, health, and computer science to teach students the fundamentals of developing new medical devices, treatments and materials. The 36-credit program offers students the opportunity to select from one of two available majors, Biomedical Engineering or Synthetic Biology. Biomedical Engineers develop artificial limbs, joints, tissues and organs as well as design diagnostic equipment, monitoring devices and drug delivery systems. Synthetic Biologists create organisms, which either produce useful biochemicals for therapeutic applications, or perform unique functions, such as creating useful biochemicals for therapeutic and industrial applications or detecting or detoxifying biohazardous chemicals.

Students will have the opportunity to work with faculty who are leaders in their fields, including specialists in the latest medical device designs, imaging systems, bioengineering and metabolic technologies.

Admissions Requirements

The Wilkes program is designed for those with a bachelor's degree in engineering or biology seeking training in bioengineering and also for those seeking to strengthen credentials for medical or other professional schools. Individuals with undergraduate degrees in other science disciplines may also be considered. Applicants must submit an online application, official undergraduate transcripts, and 2 letters of reference from science or engineering faculty.

International applicants must also submit a statement of financial guarantee and a WES evaluation of their undergraduate transcript.

All applicants must submit an official Test of English as a Foreign Language (TOEFL) or International English Language Testing System (IELTS) score, in addition to the previously-listed admissions requirements if the language of instruction of the applicant’s undergraduate degree was not English. In some cases, proof of the applicant’s language of undergraduate instruction may be requested and required.

Program Requirements

Students enrolling in the Bioengineering program will be assigned an advisor in the chosen track at the time of admission. Students are strongly encouraged to contact their advisor to discuss program prerequisites, course selections, research opportunities, and other programmatic questions.

The program has a common set of core courses for both majors. All students must take the 6 credits of core bioengineering courses, BEGR 409 Introduction to Bioengineering and BEGR 411 Integrated Product Development, at the start of the program. Students then enroll in 6 courses (18 credits) designated for their chosen major and 6 credits of electives. Students will complete their program with 6 credits of thesis work or can request in special cases and with the directors’ approval to do a 3 credit project and take one additional elective course, for a total of 36 program credits.

Biomedical Major Program Plan

<table>
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<th>Core courses- 6 credits</th>
<th>Major courses - 18 credits</th>
<th>Electives - 6 credits</th>
<th>Thesis/Project - 6 credits</th>
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36 total program credits

Provided below is a sample program plan for each major. Plans are based on full-time enrollment, which is 9 credits per semester for graduate students. Students electing to enroll part-time should discuss course scheduling with their advisor to ensure timely completion of all program requirements. In addition, students should select elective credits in consultation with their advisors, particularly if specialization knowledge is desired.

Synthetic Biology Program Plan

1. Begr 401: Applied Engineering Analysis
2. Begr 409: Introduction to Bioengineering

Suggested electives for Biomedical majors include:
- Begr 452: Nanotechnology
- Begr 477: Cellular Biophysics
- Begr 408: BioMEMs
- Begr 498: Biomechanics – Muscular-Skeleton Mechanics

Students may also elect to take courses from the Synthetic Biology track or from other Wilkes graduate programs, in consultation with their advisor, for their elective credits.
First Semester (Fall)
BEGR 409: Introduction to Bioengineering
BEGR 411: Integrated Product Development
BEGR 430: Introduction to Bioinformatics Applications

Second Semester (Spring)
BEGR 424: Molecular Biology
BEGR 465: Biochemistry
BEGR 477: Cellular Biophysics

Third Semester (Fall)
BEGR 501: Practicum in Synthetic Biology I
BEGR 599: Thesis/Project (3 Credits)
Elective

Fourth Semester (Spring)
BEGR 502: Practicum in Synthetic Biology II
BEGR 599: Thesis/Project (3 Credits)
Elective

Possible electives for Synthetic Biology majors include:

- BEGR 426: Immunology and Immunoochemistry
- BEGR 427: Medical Microbiology
- BEGR 429: Virology
- BEGR 474: Imaging in Biomedicine

Students may also elect to take courses from the Biomedical track or from other Wilkes graduate programs, in consultation with their advisor, for their elective credits.

Degree Requirements
All candidates for the Master of Science in Bioengineering degree must complete a program of thirty-six (36) credits.

BEGR. BIOENGINEERING

BEGR-401. APPLIED ENGINEERING ANALYSIS
Credits: 3 (Two hours of lecture and two hours of lab per week)
This course is a graduate level course whose focus is to present, illustrate and apply the calculus of single, multivariable and vector-valued functions to a variety of mechanical and electrical engineering and physics topics at an advanced level. Topics include ordinary differential equations, series solutions of ordinary differential equations and special functions, inner product spaces, vector analysis, operator algebra, matrix methods and eigenvalue problems, Fourier series and integrals, complex variables, Sturm-Liouville theory, transform methods and partial differential equations. (Cross-listed with [[ME-401]])

BEGR-408. BIOMEMS
Credits: 3 (Three hours of lecture and three hours of lab per week)
Fees: Lab Fee - $104
This course is about the basic foundations for the understanding of electrical, mechanical and chemical transducers in biomedical applications through learning fabrication, design and analysis. The course will have lectures to cover the theory and practical applications of imaging. Some of the lectures and assignments will be in our materials fabrication laboratories.

BEGR-409. INTRODUCTION TO BIOENGINEERING
Credits: 3 (Three hours of lecture per week)
Terms Offered: Fall
This course first covers some essential information of bioengineering and includes the required research ethics curriculum for the program. The course also samples the wide variety of bioengineering options for students who plan to enter one of the degree tracks. The beginning lectures briefly describe the scientific basis for bioengineering both from biological and engineering standpoints. Bioengineering faculty will then describe the bioengineering options in the particular engineering tracks and courses as well as the research conducted by faculty in the department. (Required for all students in Bioengineering)

BEGR-411. INTEGRATED PRODUCT DEVELOPMENT
Credits: 3 (Three hours of lecture per week)
Fees:
Organizational issues and decision-making for capital investments in new technologies. The product development and commercialization process is traced from research and development and marketing activities through the implementation phase involving the manufacturing function. Term project is a commercialization plan for a new manufacturing technology. (Cross-listed with [[ME-411]]) (Required for all students in Bioengineering)

BEGR-415. 3-D MODELING IN HUMAN ANATOMY AND PHYSIOLOGY
Credits: 3 (Two hours of lecture and three hours of lab per week)
Fees: Lab Fee - $104
This is a one-semester course that will provide a foundation in Human Anatomy and Physiology for Graduate Engineering students in preparation for the design and evaluation of biomedical devices. Topics to be covered include: anatomical terminology; cell, tissue and organ structure; as well functional anatomy of muscles, joints, nervous, cardiovascular, respiratory, digestive, and urinary systems. Laboratory exercises will include 3D modeling of these systems and physiological recording of muscle contraction, action potentials, EEG, ECG, heat rate, pulse, and respiratory movements.

BEGR-421. BIOFLUIDICS AND MICROFLUIDICS
Credits: 3 (Three hours of lecture and three hours of lab per week)
Fees: Lab Fee - $104
Students learn how to mathematically and quantitatively describe fluid flow throughout organ systems and biomedical devices. Other topics covered include how flow correlates with diseases.

BEGR-424. MOLECULAR BIOLOGY
Credits: 3 (Three hours of lecture and three hours of lab per week)
Fees: Lab Fee - $104
An introduction to molecular biology and how it is studied. Topics covered include genome structure, transcription, translation, chromatin structure and its role in gene expression, and techniques for studying gene expression and for genetic engineering. The goal is to learn enough molecular biology to figure out how to identify target genes or combinations of genes and how they might be engineered to produce desired products or to engineer organisms with desired capabilities. (Cross-listed with [[BIO-324]])
BEGR-426. IMMUNOLOGY AND IMMUNOCHEMISTRY  
**Credits:** 3 (Three hours of lecture and three hours of lab per week)  
**Fees:** Lab Fee - $104  
Immunology and Immunochemistry provides an introduction to mammalian host defense. The molecular mechanisms that account for the antigen-antibody interaction are explored, as are ways in which this interaction influences the evolution of lymphocyte populations. Mechanisms of acquired immunity, including interactions among lymphocyte subpopulations, are discussed. Lymphocyte differentiation is addressed as a developmental problem, and defense against infection is approached as an integrated response. (Cross-listed with [[BIO-326]])

BEGR-427. MEDICAL MICROBIOLOGY  
**Credits:** 3 (Three hours of lecture and three hours of lab per week)  
**Fees:** Lab Fee - $104  
Medical Microbiology provides a professional-level introduction to microbiology that is focused on application of microbiology to the study of infectious disease. Principles of molecular cell biology and biochemistry are applied to an understanding of factors influencing interactions between microbial pathogens and their hosts. Adaptations that have evolved in vertebrate hosts to limit infection are considered along with parasite adaptations that have evolved to overcome such defenses. Infection control strategies - epidemiological and chemical - are also introduced. (Cross-listed with [[BIO-327]])

BEGR-429. VIROLOGY  
**Credits:** 3 (Three hours or lecture per week)  
**Fees:** Lab Fee - $104  
Virology provides an introduction to the biology of viruses and virus-like agents. A consideration of viruses in terms of their molecular architecture and genome organization is followed by a survey of strategies employed for reproductive success of viruses, focused on the traditional 'stages' of attachment, entry, transcription, translation, genome replication, assembly and release. The course provides an overview of the major groups in the Baltimore classification, and introduces topics in host interaction and control. (Cross-listed with [[BIO-329]])

BEGR-451. MECHATRONICS/BIOINSTRUMENTATION  
**Credits:** 3 (Two hours of lecture and one hour of lab per week)  
**Fees:** Lab Fee - $104  
Mechatronics is a multidiscipline technical area defined as the synergistic integration of mechanical engineering with electronic and intelligent computer control in the design and manufacture of industrial products and processes. This course covers topics such as actuators and drive systems, sensors, programmable controllers, microcontroller programming and interfacing, and automation systems integration. (Cross-listed with [[ME-451]])

BEGR-452. NANOTECHNOLOGY  
**Credits:** 3 (Two hours of lecture and three hours of lab per week)  
**Fees:** Lab Fee - $104  
This course explores the fundamentals of nanotechnology and its applications for colloidal suspension, Electrophoretic deposition and nanosensing by understanding materials properties, micro-machining, sensor and actuator principles. Two hours of lecture and three hours of lab per week. (Cross-listed with [[ME-452]])

BEGR-465. BIOCHEMISTRY  
**Credits:** 3 (Three hours of lecture per week)  
**Fees:** Lab Fee - $104  
An introduction to metabolism and how it is studied together with an introduction to the physical and chemical properties of macromolecules and their precursors. The goal is to learn enough biochemistry and metabolism to figure out how to identify target pathways and how they might be engineered to produce desired products or to engineer organisms with desired capabilities. (Cross-listed with [[CHM-365]])

BEGR-474. IMAGING IN BIOMEDICINE  
**Credits:** 3 (Three hours of lecture and three hours of lab per week)  
**Fees:** Lab Fee - $104  
Biological and medicinal imaging techniques. This course will cover different aspects of imaging important to biomedicine including optical, scanning probe, ultrasound, X-ray and nuclear radiation techniques. The course will have lectures to cover the theory and practical applications of imaging. Some of the lectures and assignments will be in our imaging laboratories both at Wilkes and/or at our partner institutions.

BEGR-477. CELLULAR BIOPHYSICS  
**Credits:** 3 (Three hours of lecture per week)  
Cells are complex micron-sized machines that may best be understood by reverse systems engineering, which means that the understanding originated from detailed analysis of cellular functions and how they were optimized. This course focuses on a quantitative understanding of cellular processes. It is designed for students who feel comfortable with and are interested in analytical and quantitative approaches to cell biology and cell physiology.

BEGR-488. BIOMEDICAL DEVICES AND DESIGN  
**Credits:** 3 (Two hours of lecture and one hour of lab per week)  
**Fees:** Lab Fee - $104  
This course discusses the design development and evaluation of medical devices. The goal is to develop the thinking and research tools that will enable students to understand medical devices as products as commercially available technological solutions to medical needs. This total understanding is based upon the coordinate separated understandings of: 1) underlying medical science and clinical practice; 2) underlying technologies and the potential choices between available technologies; 3) engineering design; and 4) technological and business direction of companies.

BEGR-498. BIOMECHANICS – MUSCULAR-SKELETON MECHANICS  
**Credits:** 3 (Three hours of lecture and three hours of lab per week)  
**Fees:** Lab Fee - $104  
Instruction will be given towards the mechanical structure of humans and vertebrates, including the concerted motion of bone, muscles and joints as well as the stress and strain of human movements and motion. One example practical outcome of the course is towards the design of prosthetics.

BEGR-599. THESIS/PROJECT  
**Credits:** 3-6 (Three to six credits of research, proposal writing, presentation, and thesis per week)  
**Fees:** Lab Fee - $104  
Students have the option of selecting up to six credit-hours of thesis or three credit-hours of project under guidance of a thesis/project advisor. The thesis will have a committee of three members; at least two members (including the advisor) must be Wilkes faculty members. The thesis/project should be presented in an open forum.