

BIOENGINEERING (MENG)

Master of Engineering in Bioengineering

Unit: Speed School of Engineering (<https://engineering.louisville.edu/>) (SP)

Program Website (<https://engineering.louisville.edu/bioengineering/>)

Academic Plan Code(s): BE_ _MEN

Program Information

General Information

The Bachelor of Science in Bioengineering degree will provide a student with the basis to be able to complete the Master of Engineering (MEng) in Bioengineering degree. The Master of Engineering in Bioengineering degree program is accredited by the Engineering Accreditation Commission (EAC) of ABET, www.abet.org (<http://www.abet.org>).

Since the Bioengineering MEng is accredited as part of a five-year program with one-year of co-op experience, it is only available for students who have matriculated through the Bioengineering bachelor degree program at Speed School. Students who earn an undergraduate degree at a school or university other than the University of Louisville pursue the MS degree instead of the MEng degree.

Master of Engineering Program Educational Objectives

Embodying the University, Speed School of Engineering and Department of Bioengineering missions of providing an excellent education through research, innovation and a rigorous curriculum, the Department of Bioengineering Master of Engineering degree program will produce graduates who:

- a. Demonstrate advanced level academic expertise and practical engineering experience necessary to function as bioengineering professionals in a modern, ever-changing world. (Advanced Knowledge and Life-long Learning)
- b. Display competence by being selected for employment by industrial, academic or government entities or further professional/graduate studies. (Career Opportunities)
- c. Understand the broad, social, ethical and professional issues of contemporary engineering practice. (Awareness and Responsibility)

Master of Engineering Student Outcomes

In order to achieve these objectives, the Master of Engineering has the following outcomes set for its graduates.

Graduates will demonstrate:

1. An ability to identify, formulate, and solve complex engineering problems by applying advanced principles of engineering, science and mathematics.
2. An ability to apply engineering design to produce advanced solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental and economic factors.
3. An ability to develop and conduct appropriate experimentation using scientific methods to collect, analyze and interpret data, and to use engineering judgment to draw conclusions.

4. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Residency

All graduate students are expected to make steady and satisfactory progress toward the completion of degrees. A candidate for the Master of Engineering degree who does not register for credit hours must maintain active registration by paying a fee each semester for MEng residency until the degree is awarded (i.e., the candidate must maintain continuous registration, including summer terms, in Graduate Studies). Failure to pay the MEng residency fee will be cause to cancel a student's residency. Students who are not enrolled for a period of more than 12 months will be considered to have withdrawn from the program. In order to be restored to residency, the student must submit a new application, have the recommendation of the department chair, receive the approval of the Associate Dean and pay the fee for each of the semesters during which the residency was void.

Academic Performance

The J.B. Speed School of Engineering has established the following performance policies:

- a. The minimum grade point average requirement for good standing is 3.00 for all academic work completed while in graduate studies.
- b. Any student with a cumulative graduate GPA below 3.00 will be placed on academic warning. Students on academic warning are limited to enrollment for thirteen (13) credit hours in a fall or spring semester and seven (7) credit hours for summer terms.

Students who do not bring their cumulative graduate GPA back at or above a 3.00 in the semester immediately following Academic Warning, will be placed on Academic Probation for the next semester of enrollment. Students on probation are limited to enrollment for thirteen (13) credit hours in a fall or spring semester and seven (7) credit hours for summer terms. Any student who remains on academic probation for two consecutive terms may be considered for dismissal from the program.

- c. Students receiving graduate assistantships (teaching, research or service) shall be provided adequate training and shall be required to understand and adhere to University policies related to these areas. The performance of teaching, research and service duties by such students shall be periodically evaluated. Students with teaching assistantships shall be evaluated annually.
- d. Students who fail to meet performance goals or who do not meet other requirements as outlined in the admission letter, program requirements or the university catalog may be subject to academic dismissal from their programs.
- e. A maximum of eight (8) credit hours of graduate level courses taken as an undergraduate may be used to satisfy MEng degree requirements; these courses cannot have been used to also satisfy BS degree requirements.

Degree Requirements

The following degree requirements are mandatory of all master of engineering candidates:

- a. The program of study must be completed with a 3.00 GPA or better for all graduate courses used to satisfy degree requirements. Additionally, the program of study must be completed with a 3.00 GPA or better for all academic work attempted in graduate studies.

- b. Master's degree students must take at least 24 credit hours of coursework at the University of Louisville to satisfy the residency requirement for the master's degree. A maximum of six (6) credit hours of graduate credit may be transferred from accredited institutions.
- c. Students following the thesis option must follow the Procedures and Standards for Master of Engineering Theses.
- d. The total requirements must be completed within six years after admission into graduate studies. The time limit imposed by the rule may be extended in individual cases upon recommendation of the department chair and approval of the associate dean for academic and student affairs.
- e. The MEng degree cannot be conferred prior to the BS degree.

Admission Standards

Since the Bioengineering MEng is accredited as part of a five-year program with one-year of co-op experience, it is only available for students who have matriculated through the Bioengineering bachelor's degree program at J. B. Speed School of Engineering.

The application form is available online (<https://engineering.louisville.edu/meng-graduate-application-form/>).

The requirements for admission or readmission to a master of engineering program are:

- a. Submission of a completed MEng application for the field of specialization in which the student is earning a bachelor degree from the J.B. Speed School of Engineering. Students can be admitted to the MEng program with fewer than thirteen (13) credit hours of BS degree requirements remaining and no later than two years post-conferral of their baccalaureate degree;
- b. Recommendation by the faculty and chair of the student's department for admission or readmission to graduate studies;
- c. Cumulative baccalaureate grade point average of 2.75. However, those students with cumulative baccalaureate grade-point averages from 2.50 to 2.75 may be admitted upon petition and approval of the chair and faculty of the department.

A student becomes a candidate for the master of engineering degree upon admission to graduate studies and initial registration as a graduate student.

Program Requirements

The Master of Engineering (MEng) in Bioengineering degree requires the following over and above the Bachelor of Science in Bioengineering Degree

Required Coursework

Code	Title	Hours
BE 621	Bioinstrumentation	4
BE 654	Advanced Physiology for Engineers	3
IE 563	Experimental Design in Engineering	3
BE Electives ^{1,2}		9
Technical Electives ^{1,3}		6
Select one of the following:		6
<i>Thesis Option</i>		
BE 697	Master of Engineering Thesis in Bioengineering ⁴	
<i>Non-Thesis Option</i>		

BE 691	Bioengineering Non-thesis Design/Research Project	
Technical Elective ^{1,3}		
Minimum Total Hours		31

The Master of Engineering degree must be completed with a 3.00 GPA or better for all graduate courses used to satisfy degree requirements. Additionally, the Master of Engineering degree must be completed with a 3.00 GPA or better for all academic work attempted in Graduate Studies.

A maximum of eight (8) credit hours of graduate-level courses taken as an undergraduate may be used to satisfy MEng degree requirements; these courses cannot have been used to also satisfy BS degree requirements.

¹ Electives must be chosen so that at least one-half of the total credits counted toward the degree, exclusive of thesis, are 600-level

² BE Electives must be chosen from the following approved list (see below). All prerequisites must be satisfied. A minimum of nine (9) credit hours and maximum of fifteen (15) credit hours of electives must be selected.

³ Technical Electives must be chosen from the following approved list. All prerequisites must be satisfied. Please note that all BE Electives can be counted toward Technical Electives, however, only three (3) credit hours from EM and three (3) credit hours from BIOC, CHEM, BE 695, or MATH may be used towards degree requirements.

⁴ For the thesis option, a student is required to select both an approved MEng thesis topic and the director and members of the thesis committee during the first term of Graduate Studies. The thesis director must give approval for enrollment in BE 697.

BE Electives

Code	Title	Hours
BE 500	Special Topics in Bioengineering	3
BE 522	Biomedical Acoustics	3
BE 524	LabVIEW for Bioengineers	3
BE 530	Machine Learning in Python	3
BE 540	Machine Learning in Medicine	3
BE 542	Medical Image Computing	3
BE 552	Introduction to Tissue Engineering	3
BE 553	Nanoscale Bioengineering: Application and Methodology of Nanobiomaterials in Bioengineering	3
BE 581	Advanced Computer-Aided Design and Manufacturing for Bioengineers	3
BE 593	Independent Study in Bioengineering	1-4
BE 600	Advanced Topics in Bioengineering	1-6
BE 605	Tissue and Molecular Biology Techniques Laboratory	3
BE 611	Cardiovascular Dynamics	3
BE 630	Biomechanical Computer Modeling and Simulation of Human Movement	3
BE 639	Injury Biomechanics	3
BE 640	Computational Methods for Medical Image Analysis	3

BE 645	Artificial Intelligence and Radiomics	3	ECE 521	Digital Signal Processing Laboratory	1
BE 650	Advanced Biomaterials	3	ECE 530	Introduction to Random Processes and Estimation Theory	3
BE 658	Rehabilitation Engineering and Assistive Technology	3	ECE 533	Integrated Circuit Design	3
BE 670	Cellular Mechanobiology in Cancer	3	ECE 543	Fundamentals of Microfabrication and MEMS	3
BE 683	Artificial Organs	3	ECE 544	Microfabrications/MEMS Laboratory	1
BE 685	Modeling of Biological Phenomena	3	ECE 620	Pattern Recognition and Machine Intelligence	3
BE 693	Independent Study in Bioengineering	1-6	ECE 641	Medical Imaging Systems	3
			ECE 643	Introduction to Biomedical Computing	3
			ECE 655	Pattern Recognition and Machine Intelligence Laboratory	1
			ECE 675	Nanostructure Self-Assembly	3
			EM 525	Project Management	3
			EM 613	Operations Management	3
			EM 628	Engineering Management	3
			EM 661	Engineering Statistics II	3
			IE 580	Introduction to Human Factors Engineering and Ergonomics	3
			IE 581	Advanced Topics in Human Factors Engineering	3
			IE 631	Advanced Quality Control	3
			MATH 501	Introduction to Analysis I - CUE (http://catalog.louisville.edu/undergraduate/general-education-requirements/)	3
			MATH 502	Introduction to Analysis II	3
			ME 512	Finite Element Methods for Mechanical Design I	3
			ME 555	Introduction to Micro and Nanotechnology	3
			ME 565	Advanced Engineering Mathematics I	3
			ME 606	Continuum Mechanics	3
			ME 612	Finite Element Methods for Mechanical Design II	3
			ME 638	Computational Methods in Fluid Flow and Heat Transfer	3
			ME 644	Mechatronics	3
			ME 650	Biofluid Mechanics	3
			ME 651	Kinematics and Kinetics of Human Movement	3

Technical Electives

Code	Title	Hours
BE 500	Special Topics in Bioengineering	3
BE 522	Biomedical Acoustics	3
BE 524	LabVIEW for Bioengineers	3
BE 540	Machine Learning in Medicine	3
BE 552	Introduction to Tissue Engineering	3
BE 553	Nanoscale Bioengineering: Application and Methodology of Nanobiomaterials in Bioengineering	3
BE 581	Advanced Computer-Aided Design and Manufacturing for Bioengineers	3
BE 593	Independent Study in Bioengineering	1-4
BE 600	Advanced Topics in Bioengineering	1-6
BE 605	Tissue and Molecular Biology Techniques Laboratory	3
BE 611	Cardiovascular Dynamics	3
BE 630	Biomechanical Computer Modeling and Simulation of Human Movement	3
BE 639	Injury Biomechanics	3
BE 640	Computational Methods for Medical Image Analysis	3
BE 645	Artificial Intelligence and Radiomics	3
BE 650	Advanced Biomaterials	3
BE 658	Rehabilitation Engineering and Assistive Technology	3
BE 670	Cellular Mechanobiology in Cancer	3
BE 683	Artificial Organs	3
BE 685	Modeling of Biological Phenomena	3
BE 693	Independent Study in Bioengineering	1-6
BE 695	Bioengineering Research Design & Methods	3
BIOC/CHEM 545	Biochemistry I	3
BIOC/CHEM 547	Advanced Biochemistry II	3
BIOC/CHEM 645	Advanced Biochemistry I	4
BIOC/CHEM 647	Advanced Biochemistry II	4
BIOL 653	Advanced Chronic Disease Biology	4
CSE 535	Database Systems	3
CSE 619	Design and Analysis of Computer Algorithms	3
CSE 628	Computer Graphics	3
CSE 632	Data Mining	3
CSE/ECE 641	Medical Imaging Systems	3
CSE 660	Introduction to Bioinformatics	3
ECE 520	Digital Signal Processing	3