BIOENGINEERING (BE)

Subject-area course lists indicate courses currently active for offering at the University of Louisville. Not all courses are scheduled in any given academic term. For class offerings in a specific semester, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm).

500-level courses generally are included in both the undergraduate- and graduate-level course listings; however, specific course/section offerings may vary between semesters. Students are responsible for ensuring that they enroll in courses that are applicable to their particular academic programs.

Course Fees

Some courses may carry fees beyond the standard tuition costs to cover additional support or materials. Program-, subject- and course-specific fee information can be found on the Office of the Bursar website (https://louisville.edu/bursar/tuitionfee/university-fees/).

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
<th>Term Typically Offered</th>
<th>Prerequisite(s)</th>
<th>Description</th>
<th>Graduation Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE 101</td>
<td>Introduction to Bioengineering</td>
<td>1 Unit</td>
<td>Spring Only</td>
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<tr>
<td>BE 288</td>
<td>Bioengineering Co-op Education Seminar</td>
<td>0 Units</td>
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<td>Pass/Fail</td>
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<tr>
<td>BE 289</td>
<td>Bioengineering Co-op Education I</td>
<td>1 Unit</td>
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<td>Pass/Fail</td>
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<tr>
<td>BE 310</td>
<td>Biotransport Phenomena</td>
<td>3 Units</td>
<td>Spring Only</td>
<td>ENGR 205, ME 206, and ME 251</td>
<td>Introduction to fundamental concepts of momentum, heat, and mass transport with applications to biological and medical engineering science and design. Properties of biofluids. Conservation equations in integral and differential forms.</td>
<td>Pass/Fail</td>
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<tr>
<td>BE 340</td>
<td>Computational Methodologies in Bioengineering</td>
<td>3 Units</td>
<td>Summer Only</td>
<td>ENGR 205</td>
<td>The main goal of the course is to introduce students to high-performance computing tools which are crucial to many bioengineering and scientific applications and equip students with basic knowledge of state-of-the-art computing tools available.</td>
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<tr>
<td>BE 354</td>
<td>Anatomy and Physiology</td>
<td>3 Units</td>
<td>Spring Only</td>
<td>BIOL 240</td>
<td>The purpose of this course is to cover the basic structure and function of the major systems of the human body.</td>
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<tr>
<td>BE 359</td>
<td>Cell and Molecular Biology for Bioengineers</td>
<td>3 Units</td>
<td>Spring Only</td>
<td>BIOL 240</td>
<td>This course examines the fundamental principles of cell and molecular biology in humans.</td>
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<tr>
<td>BE 360</td>
<td>Biomechanics Principles</td>
<td>3 Units</td>
<td>Spring Only</td>
<td>ENGR 205 and CEE 205</td>
<td>Introduction to the mechanical behavior of biological tissues and systems. Methods for the analysis of rigid body and deformational mechanics applied to biological tissues including bone, muscle, and connective tissues.</td>
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</tbody>
</table>

For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)
BE 389. Bioengineering Co-op Education II
Grading Basis: Pass/Fail
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): BE 289.
Fee: An additional $300.00 is charged for this course.
Description: Second cooperative education work term in an area directly related to the field of specialization of their degree program. Required for Professional School of Engineering students.
Course Attribute(s): CBL - This course includes Community-Based Learning (CBL). Students will engage in a community experience or project with an external partner in order to enhance understanding and application of academic content.

For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 405. Practicum in Bioengineering Education
Term Typically Offered: Spring Only
Prerequisite(s): BE 310 and BE 360 and consent of instructor.
Description: A guided learning experience in inquiry-based instructional techniques and best practices in STEM education that includes field experience as an undergraduate teaching assistant. Permission to enroll required. May be repeated for a maximum of 3 credit hours.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 420. Biosystems & Signals
Term Typically Offered: Spring Only
Prerequisite(s): BE 340.
Description: This course covers linear systems theory, including convolution, Fourier, Laplace, and Z-transforms. The emphasis is on understanding the underlying mathematics in a practical sense.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 423. Bioengineering Measurements Laboratory
Term Typically Offered: Spring Only
Prerequisite(s): BE 322.
Description: Laboratory to illustrate basic principles taught in Circuits and Devices for Bioengineers.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 430. Biosystems Controls
Term Typically Offered: Fall Only
Prerequisite(s): BE 322, BE 420.
Description: Classical approach to analyze and design linear and nonlinear control systems, with emphasis on nonlinearity of physiological control systems, e.g., neuromusculoskeletal, cardiovascular, thermal and mass transfer systems of the body.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 450. Biomaterials & Biocompatibility
Term Typically Offered: Summer Only
Prerequisite(s): CHEM 341, ME 251 and BE 360.
Description: Introduces biomaterials and the clinical relevance of biomaterial performance. The course will cover polymer synthesis, characterization, mechanical testing, surface modification and biocompatibility issues, e.g. protein adsorption, immune response, and sterilization.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 453. Introduction to Molecular Bioengineering
Term Typically Offered: Fall Only
Prerequisite(s): CHEM 341 and BE 359.
Description: Demonstrate how molecules are used as building blocks to engineer surfaces and materials with specific attributes/function. Introduces biomimetic design principles for biomedical materials and devices to control performance/function of materials.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 460. Biomechanics of Tissues and Organs
Term Typically Offered: Fall Only
Prerequisite(s): BE 360 and BE 354.
Description: Provide students with introductory materials for various interdisciplinary fields in biomechanics. The topics include orthopaedic biomechanics, musculoskeletal biomechanics and cardiovascular biomechanics.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 480. Biomedical Device Design
Term Typically Offered: Spring Only
Prerequisite(s): BE 423 (or concurrent) and BE 450 (or concurrent).
Description: Medical device design for surgery, patient care and patient monitoring. Emphasizes design criteria and process, human factors, patient care, bench-top testing, safety, FDA regulation, market readiness and legal liability.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 489. Bioengineering Co-op Education III
Grading Basis: Pass/Fail
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): BE 389.
Fee: An additional $300.00 is charged for this course.
Description: Third cooperative education work term in an area directly related to the field of specialization of their degree program. Required for Professional School of Engineering students.
Course Attribute(s): CBL - This course includes Community-Based Learning (CBL). Students will engage in a community experience or project with an external partner in order to enhance understanding and application of academic content.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)
BE 491. Capstone A 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): BE 423 and BE 450; Senior standing in Bio-engineering.
Corequisite(s): BE 497.
Description: Course will introduce students to an intermediate level of LabVIEW (Laboratory Virtual Instrument Engineering Workbench) available from National Instruments (Austin, TX). LabVIEW is the worldwide industry standard graphical programming environment for developing data acquisition, instrument control, and industrial automation software. Students will explore core programming fundamentals common to all programming languages by using LabVIEW software to develop independent programs and data acquisition solutions using a combination of LabVIEW, data acquisition hardware, and standard test instrumentation hardware.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 491. Capstone B - CUE 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): BE 354 and Senior standing in bio-engineering.
Corequisite(s): BE 497.
Description: Team-oriented design of a biomedical/biological mechanism, system or process satisfying a set of open-ended requirements. Written reports and oral presentations are required.
Course Attribute(s): CUE - This course fulfills the Culminating Undergraduate Experience (CUE) requirement for certain degree programs. CUE courses are advanced-level courses intended for majors with at least 90 earned credits/senior-level status. CBL - This course includes Community-Based Learning (CBL). Students will engage in a community experience or project with an external partner in order to enhance understanding and application of academic content.
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BE 500. Special Topics in Bioengineering 3 Units
Term Typically Offered: Fall, Spring, Summer
Description: This course will be devoted to topics that usually are not treated in detail in the general curriculum.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 522. Biomedical Acoustics 3 Units
Term Typically Offered: Spring Only
Prerequisite(s): BE 420.
Description: A course to introduce the fundamental principles of physical acoustics with an emphasis on biomedical applications. Major concepts covered include acoustic wave physics, transducers, and ultrasound imaging.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 524. LabVIEW for Bioengineers 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): BE 340 or equivalent.
Description: This course will introduce students to an intermediate level of LabVIEW available from National Instruments (Austin, TX). LabVIEW is the worldwide industry standard graphical programming environment for developing data acquisition, instrument control, and industrial automation software. Students will explore core programming fundamentals common to all programming languages by using LabVIEW software to develop independent programs and data acquisition solutions using a combination of LabVIEW, data acquisition hardware, and standard test instrumentation hardware.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 530. Machine Learning in Python 3 Units
Term Typically Offered: Fall, Spring
Prerequisite(s): BE 340 or graduate/professional standing.
Description: This course covers programming concepts in Python, machine learning concepts, and application of machine learning into biomedical and other problems using Python. Students will learn about the most applicable Python libraries that deal with different machine learning tools. Students are expected to work on a team project and write technical reports.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 540. Machine Learning in Medicine 3 Units
Term Typically Offered: Spring Only
Prerequisite(s): BE 420.
Description: This course will introduce students to an intermediate level of LabVIEW available from National Instruments (Austin, TX). LabVIEW is the worldwide industry standard graphical programming environment for developing data acquisition, instrument control, and industrial automation software. Students will explore core programming fundamentals common to all programming languages by using LabVIEW software to develop independent programs and data acquisition solutions using a combination of LabVIEW, data acquisition hardware, and standard test instrumentation hardware.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 542. Medical Image Computing 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): BE 340 or graduate/professional standing.
Description: This course will introduce students to an intermediate level of LabVIEW available from National Instruments (Austin, TX). LabVIEW is the worldwide industry standard graphical programming environment for developing data acquisition, instrument control, and industrial automation software. Students will explore core programming fundamentals common to all programming languages by using LabVIEW software to develop independent programs and data acquisition solutions using a combination of LabVIEW, data acquisition hardware, and standard test instrumentation hardware.
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BE 543. Computer Tools for Medical Image Analysis  
**Term Typically Offered:** Summer Only  
**Prerequisite(s):** BE 340 or graduate/professional standing.  
**Description:** This course covers: 1) Essential computer software that can be used for handling all types of medical data, 2) advanced computer software that is used for medical image analysis, such as segmentation, registration, motion correction, etc., and 3) development of comprehensive computer-aided diagnosis systems based on these ready-to-go software packages.  
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 544. Artificial Intelligence Techniques in Digital Pathology  
**Term Typically Offered:** Spring Only  
**Prerequisite(s):** BE 542 & skills in programming languages R and Python; or consent of instructor.  
**Description:** This course provides both theoretical and practical information about computer vision and AI techniques required to process and analyze microscopic images as a part of the evolving transition to digital pathology. This evolution will enable the use of AI models in pathology to aid pathologists and healthcare professionals in the management and the diagnosis of different diseases.  
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BE 552. Introduction to Tissue Engineering  
**Term Typically Offered:** Spring Only  
**Prerequisite(s):** CHEM 341, BE 354, BE 359, and BE 450.  
**Description:** Design, development and clinical application of tissue engineered components, including blood vessels, bone, cartilage, pancreas, liver and skin, for use in the human body.  
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BE 553. Nanoscale Bioengineering: Application and Methodology of Nanobiomaterials in Bioengineering  
**Term Typically Offered:** Spring Only  
**Prerequisite(s):** BE 450 or BE 453 or permission of department chair.  
**Description:** An introduction to the fundamental principles of nanoengineering with a focus on 1) synthetic methodologies of tailored nanobiomaterials (physical, chemical and electrochemical); 2) nanobiomaterial characterization using advanced analytical, microscopic and spectroscopic techniques; and 3) therapeutic and diagnostic applications.  
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BE 581. Advanced Computer-Aided Design and Manufacturing for Bioengineers  
**Term Typically Offered:** Fall, Spring, Summer  
**Prerequisite(s):** BE 340 or by permission of Department Chair.  
**Description:** An introduction to the engineering design and manufacturing processes for bioengineering applications with an emphasis on the use of modern computer-based analysis, design and presentation tools as well as manufacturing techniques such as casting, machining, forming and assembly for polymer and metal-based materials.  
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BE 593. Independent Study in Bioengineering  
**Term Typically Offered:** Fall, Spring, Summer  
**Prerequisite(s):** Faculty consent.  
**Description:** A theoretical or experimental investigation of a problem area related to Bioengineering.  
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)