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 (http://louisville.edu/bursar/tuitionfee).

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: An introduction to 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 (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 540. Machine Learning in Medicine 3 Units
Term Typically Offered: Spring Only
Prerequisite(s): BE 420.
Description: Topics: 1) fundamentals of medical data, 2) application of machine learning models & algorithms to medicine, 3) learning from data & classification of disorders, and 4) overview of health data, collection with sensors, body area networks, brain image data and other publicly available medical applications data. Students will learn about machine learning applications to real world medical data through examples and reading papers. 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 542. Medical Image Computing 3 Units
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): BE 340 and BE 420.
Description: Fundamentals of 2-D and 3-D image computing, application of image computing algorithms to medical images, enhancement and restoration of 2-D and 3-D medical data, and fundamentals of machine vision and medical data visualization. Students will learn image restoration, computer vision and visualization techniques with applications to medical data through examples and reading papers. 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 551. Gene and Drug Delivery 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): BE 340 and BE 450, or graduate standing.
Description: This course covers advanced topics of gene and drug delivery, including the physiological barriers and challenges to delivery, biomaterials used in delivery, considerations for specificity of drug/gene targeting, nanoscale delivery vehicles, the delivery of biologies and vaccines, and intracellular delivery. In addition, this course integrates literature and discussion regarding specific platform design and delivery considerations against cancer, viral, and bacterial applications. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

BE 552. Introduction to Tissue Engineering 3 Units
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. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)
BE 553. Nanoscale Bioengineering: Application and Methodology of Nanobiomaterials in Bioengineering 3 Units
Prerequisite(s): BE 450 or BE 453 or permission of department chair.
Description: An introduction to the fundamental principles of nanobiomaterial characterizations and their applications.

BE 581. Advanced Computer Aided Design and Manufacturing for Bioengineers 3 Units
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 the assembly of polymer and metal-based materials.

BE 593. Independent Study in Bioengineering 1-4 Units
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): Faculty consent.
Description: A theoretical or experimental investigation of a problem area related to Bioengineering.

BE 600. Advanced Topics in Bioengineering 1-6 Units
Prerequisite(s): Graduate/Professional Standing in Bioengineering or Consent of Instructor.
Description: An advanced course in bioengineering topics not covered by regularly scheduled courses.

BE 601. Bioengineering Doctoral Seminar 1 Unit
Prerequisite(s): Admission to PhD in Interdisciplinary Studies with a Specialization in Translational Bioengineering.
Description: Current research topics in the field of translational bioengineering will be presented and discussed. Sessions will include guest speakers, student presentations on research projects with interaction and feedback from students and faculty, and critical discussion of scientific literature.

BE 602. Graduate Internship in Bioengineering 2 Units
Grading Basis: Pass/Fail
Prerequisite(s): Admission to Graduate Study and Chair Permission.
Description: This course provides the structure and focus for the graduate intern field assignment to ensure that the assignment is appropriate and consistent with the intern's graduate course of study and professional development.

BE 603. Bioengineering Research Ethics 2 Units
Prerequisite(s): Admission to the PhD in Interdisciplinary Studies, specialization in Translational Bioengineering program or by permission of Department Chair.
Description: Complex ethical issues facing bioengineers will be addressed, including conflicts of interest, patient rights, protection, beneficence and confidentiality, equitable allocation of scarce health resources, research misconduct, animal experimentation, and clinical trails for new medical devices.

BE 605. Tissue & Molecular Biology Techniques Laboratory 3 Units
Term Typically Offered: Summer Only
Prerequisite(s): BE 359 or equivalent.
Description: Introduces students to techniques used in tissue and molecular biology laboratories including cell and tissue culture, cell assays, cell and tissue imaging techniques and sterilization techniques.

BE 611. Cardiovascular Dynamics 3 Units
Prerequisite(s): Graduate or professional standing in Bioengineering.
Description: Review of basic cardiovascular physiology. Application of basic engineering principles, including electrical and mechanical analog models to describe cardiovascular function and data acquisition and analysis techniques to develop medical devices and instrumentation.

BE 621. Bioinstrumentation 4 Units
Term Typically Offered: Fall Only
Prerequisite(s): Graduate/Professional Standing; and BE 354 and BE 423 or equivalent(s); or consent of instructor.
Description: Analysis and design of Bioinstrumentation. Basic circuitry, electronics and laboratory techniques including sensors, transducers, biopotentials, amplifiers, measurement and safety.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
<th>Prerequisite(s)</th>
<th>Description</th>
<th>Term Typically Offered</th>
<th>Eco System</th>
<th>Notes</th>
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<tbody>
<tr>
<td>BE 630</td>
<td>Biomechanical Computer Modeling and Simulation of Human Movement</td>
<td>3</td>
<td>Prerequisite(s): Graduate/professional standing; BE 354 or equivalent.</td>
<td>Description: Development and application of musculoskeletal computer modeling and simulation techniques to analyze human movement biomechanics. For class offerings for a specific term, refer to the Schedule of Classes.</td>
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<td>Cross-listed with ME 639.</td>
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<td>BE 639</td>
<td>Injury Biomechanics</td>
<td>3</td>
<td>Prerequisite(s): ME 649 or BE 354 or equivalent, or permission of the instructor.</td>
<td>Description: Application of mechanics to the study of human injury. Response of the human body to injurious conditions. Injury tolerance of the human body. Applications to child abuse, transportation safety and the medico-legal environment. Note: Cross-listed with ME 639. For class offerings for a specific term, refer to the Schedule of Classes.</td>
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<td>BE 640</td>
<td>Computational Methods for Medical Image Analysis</td>
<td>3</td>
<td>Prerequisite(s): BE 420.</td>
<td>Description: This course covers the theory of stochastic and geometric models of medical imaging, including spatial interaction models, intensity models, and geometric shape models. 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.</td>
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<td>Cross-listed with ME 639.</td>
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<td>BE 650</td>
<td>Advanced Biomaterials</td>
<td>3</td>
<td>Prerequisite(s): BE 450 or consent of instructor.</td>
<td>Description: Advanced topics on the use of biomaterials, and their performance, in reconstructive surgery. Specifically skin, nerve, bone, and soft tissue regeneration utilized for burn patients, cancer patients, and trauma patients. For class offerings for a specific term, refer to the Schedule of Classes.</td>
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<td>Cross-listed with ME 639.</td>
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<td>BE 654</td>
<td>Advanced Physiology for Engineers</td>
<td>3</td>
<td>Prerequisite(s): BE 354.</td>
<td>Description: This course provides an in-depth view of the fundamental principles of how biochemistry and physiology are integrated. Emphasis is placed on the physiologic mechanisms for feedback control of physiologic function in humans. For class offerings for a specific term, refer to the Schedule of Classes.</td>
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<td>Cross-listed with ME 658.</td>
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<td>BE 658</td>
<td>Rehabilitation Engineering and Assistive Technology</td>
<td>3</td>
<td>Prerequisite(s): ME 649 or BE 354 or equivalent, or permission of instructor.</td>
<td>Description: Introduction to rehabilitation engineering and assistive technology. Medical aspects of disability, assistive technology applications and current rehabilitation research. Note: Cross-listed with ME 658. For class offerings for a specific term, refer to the Schedule of Classes.</td>
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<td>BE 668</td>
<td>Translational Bioengineering teaching Practicum</td>
<td>2</td>
<td>Prerequisite(s): Admission to Translational Bioengineering PhD program and permission of course instructor. Description: A guided learning experience in inquiry-based instructional techniques and best practices in engineering education that includes field experience as a graduate instructor. For class offerings for a specific term, refer to the Schedule of Classes.</td>
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<td>Cross-listed with ME 658.</td>
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<td>BE 680</td>
<td>Bio-Micro</td>
<td>3</td>
<td>Prerequisite(s): Graduate/Professional standing and ECE 543, or instructor’s permission. Description: Application of microtechnology principles to the biomedical field in areas that include tissue engineering, lab-on-a-chip, biosensors, drug delivery, etc. Application-specific criteria supporting the need for miniaturization. For class offerings for a specific term, refer to the Schedule of Classes.</td>
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<td>Cross-listed with ME 639.</td>
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<td>BE 683</td>
<td>Artificial Organs</td>
<td>3</td>
<td>Term Typically Offered: Spring Only</td>
<td>Prerequisite(s): Graduate/professional standing in bioengineering. Description: Bioengineering design of artificial organ replacement systems and their clinical usage. Commercially available systems analyzed for mass transfer efficiency; biomechanics and hemodynamics; and size and efficiency of the device. For class offerings for a specific term, refer to the Schedule of Classes.</td>
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<td>BE 685</td>
<td>Modeling of Biological Phenomena</td>
<td>3</td>
<td>Term Typically Offered: Summer Only</td>
<td>Prerequisite(s): Graduate/professional standing in Bioengineering, BE 359 and BE 354 or equivalent(s). Description: Introduces basic concepts of the development, analysis, and evaluation of mathematical models of biological systems. Demonstrates how modeling related to genetic, biochemical, physiological, and/or ecological systems is performed by combining both biological and mathematical information, with the goal to apply these techniques in the field of translational bioengineering. Sessions will include critical discussion of scientific literature and student presentations on a research project with interaction and feedback from students and faculty. For class offerings for a specific term, refer to the Schedule of Classes.</td>
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<td>Cross-listed with ME 639.</td>
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BE 691. Bioengineering Non-thesis Design/Research Project 3 Units
**Term Typically Offered:** Summer Only
**Prerequisite(s):** Graduate/Professional standing in bioengineering, BE 491, and BE 497.
**Description:** Design or research project involving a literature search, project planning, design objectives, fabrication and/ or experimentation, analysis, technical report writing, and oral presentation under a faculty member's guidance. Final technical report is required to be presented orally to course instructor and faculty mentor for graded evaluation.
**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.

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**BE 692. Bioengineering Clinical Rotation** 2 Units
**Prerequisite(s):** Successful completion of Translational Bioengineering qualifying exam, permission of advisor and program director, and HIPAA certified.
**Description:** Students will observe day to day clinical activities associated with patient care by participating in clinical rounds and/or scheduled specialty clinics led by residents, fellow and/or clinical faculty. Exposure to the clinical setting will allow students to gain an understanding of concepts such as patient history, disorder/disease presentation, diagnostics, clinical decision making, treatment modalities, disease management, procedures and clinical outcomes. Students must work with their PhD advisor and the ISSTBE-PhD Program Director to identify clinical rotation opportunities in specialty areas of interests within the Schools of Medicine or Dentistry.
**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 693. Independent Study in Bioengineering** 1-6 Units
**Prerequisite(s):** Faculty consent.
**Description:** An advanced 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)

**BE 695. Bioengineering Research Design & Methods** 3 Units
**Term Typically Offered:** Spring Only
**Prerequisite(s):** Graduate/Professional standing.
**Description:** Focus on study designs & methodologies and their appropriate application. Emphasis placed on development of specific aims, testable hypotheses, and interpretation and communication of research findings. Data analysis concerns and strategies for parametric and non-parametric applications will be addressed using SPSS. Students will learn to communicate scientific methodologies and findings, and to interpret their
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

**BE 697. Master of Engineering Thesis in Bioengineering** 1-6 Units
**Prerequisite(s):** Graduate/Professional standing in bioengineering.
**Description:** Original design or research activity in a bioengineering discipline, under the direction of a faculty member. A written thesis must be presented to a faculty committee and defended. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

**BE 698. Master of Science Thesis in Bioengineering** 1-6 Units
**Term Typically Offered:** Fall, Spring, Summer
**Prerequisite(s):** Graduate or Professional school standing and permission of Department Chair.
**Description:** Experimental or design-based thesis research performed as part of Master of Science degree requirements. A written thesis is required to be presented and defended orally and submitted to the faculty for approval.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

**BE 699. Dissertation Research** 3-15 Units
**Prerequisite(s):** Successful completion of the Translational Bioengineering PhD qualifying exam.
**Description:** Original research activity in an appropriate translational bioengineering discipline, under the direction of a graduate faculty member affiliated with PhD in Interdisciplinary Studies with a Specialization in Translational Bioengineering (ISSTBE PHD). For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

**BE 700. Dissertation Research-Translational Bioengineering** 1-15 Units
**Grading Basis:** Pass/Fail
**Term Typically Offered:** Fall, Spring, Summer
**Prerequisite(s):** Dissertation director approval.
**Description:** Program director approval for initial credits. Original research activity in bioengineering under the direction of a Bioengineering graduate faculty member. Permission of program director required to register for initial credits. Permission of dissertation director required. A written dissertation must be submitted to a dissertation examination committee. The dissertation must also be orally defended. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)