Biological Engineering (BIOL_EN)

BIOL_EN 1000: Introduction to Biological Engineering
For first semester engineering students. Develop appreciation for professional engineering. Students will participate with senior design students to conceptualize a case-study problem.

Credit Hours: 1-2

BIOL_EN 2000: Professional Development in Engineering
A review of professional opportunities, registration, ethics, and societies.

Credit Hours: 1-2
Prerequisites: sophomore standing

BIOL_EN 2080: Introduction to Programming for Engineers
This course teaches how to write scientific programs for analysis of data and simulation of physical phenomena using Matlab. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: MATH 1500

BIOL_EN 2180: Engineering Analysis of Bioprocesses
Material and Energy Balances. Integrating principles of physics, chemistry and mathematics to analyze steady state and transient biological/biomedical processes. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: MATH 1700, CHEM 1320, PHYSCS 2750. Restricted to Biological Engineering students only
Recommended: BIOL_EN 2080

BIOL_EN 3070: Biological Fluid Mechanics
Basic principles of fluid mechanics applied to transport processes in biological systems. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: PHYSCS 2750 and MATH 1700

BIOL_EN 3075: Introduction to Materials Engineering
Course covers concepts and techniques in materials engineering from an engineering design perspective, materials requirements for design, and fundamentals; intended for undergraduate engineering students. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: MATH 2300, ENGINR 1200
Corequisites: One of the following BIOL_EN 3180, CH_ENG 3261, MAE 4231, MAE 4300, or instructor consent

BIOL_EN 3170: Biomaterials
Engineering sciences and design will be leverage for the study and design of biomaterials. Understanding the structure-property relationship between biomaterials and tissue will be addressed for implant design.

Credit Hours: 3
Corequisites: BIOL_EN 2180, ENGINR 2200 or instructor’s consent

BIOL_EN 3170W: Biomaterials - Writing Intensive
Engineering sciences and design will be leverage for the study and design of biomaterials. Understanding the structure-property relationship between biomaterials and tissue will be addressed for implant design.

Credit Hours: 3
Prerequisites: ENGLISH 1000
Corequisites: BIOL_EN 2180, ENGINR 2200 or instructor’s consent

BIOL_EN 3180: Heat and Mass Transfer in Biological Systems
Principles of heat and mass transfer and their applications in biomedical, bioenvironmental, and bioprocessing engineering.

Credit Hours: 3
Prerequisites or Corequisites: ENGINR 2300 or CH_ENG 3261
Prerequisites: BIOL_EN 2180 or CH_ENG 2225

BIOL_EN 4001: Topics in Biological Engineering
Current and new technical developments in biological engineering.

Credit Hours: 3
Prerequisites: instructor’s consent

BIOL_EN 4070: Bioelectricity
(cross-leveled with BIOL_EN 7070). Application of engineering approaches to understand bioelectricity at the cellular level including the equivalent circuit of cell membranes and the electronic design of patch-clamp amplifiers.

Credit Hours: 3
Prerequisites: PHYSCS 2760 and BIOL_EN 3180

BIOL_EN 4085: Problems in Biological Engineering
Supervised independent study at the undergraduate level.

Credit Hour: 1-5
Prerequisites: instructor’s consent

BIOL_EN 4150: Soil and Water Conservation Engineering
(same as CV_ENG 4710; cross-leveled with BIOL_EN 7150, CV_ENG 7710). Urban and rural run-off and erosion analysis. Design and layout of erosion control structures.

Credit Hours: 3
Recommended: BIOL_EN 2180 or CV_ENG 3200

BIOL_EN 4160: Food Process Engineering
(cross_leveled with BIOL_EN 7160). Study of transport phenomena and unit operations in food processing systems. Emphasis on fluid flow and heat transfer in food processing, preservation processes, refrigeration, freezing, psychrometrics, and dehydration.

Credit Hours: 3
Prerequisites: BIOL_EN 2180 or CV_ENG 3200

BIOL_EN 4170: Biomaterials Interfaces of Implantable Devices
(cross-leveled with BIOL_EN 7170). Surface structures and properties to improve biocompatibility will be studied. Engineering sciences and design will be leverage in the design of an improved biocompatible surface.

Credit Hours: 3
**BIOL_EN 4315: Principles of Biochemical Engineering**
(same as CH_ENG 4315; cross-leveled with BIOL_EN 7315, CH_ENG 7315). This general introduction to bioprocess engineering covers the fundamentals of microbiology and biochemistry in the context of a biomass refinery. Analyses proceed through the use of mass balances, energy balances, and empirical or theoretical models.

**Credit Hours:** 3  
**Prerequisites:** BIOL_EN 2180 (for biological engineering students) or CH_ENG 2225 (for chemical engineering students)  
**Recommended:** BIOL_EN 3180 (for biological engineering students) or CH_ENG 3234 (for chemical engineering students) - or- Consent of instructor

**BIOL_EN 4316: Biomass Refinery Operations**
(same as CH_ENG 4316; cross-leveled with BIOL_EN 7316, CH_ENG 7316). Design and operation of processes for conversion and/or fractionation of biomass and associated upstream and downstream unit operations. Emphasis on separations and product recovery.

**Credit Hours:** 3

**Recommended:** BIOL_EN 2180 or CH_ENG 2225 (for Chemical Engineering students) or instructor's consent

**BIOL_EN 4320: Introduction to Biomedical Imaging**
(same as PHYSCS 4420; cross-leveled with BIOL_EN 7420, PHYSCS 7420). This course offers a broad introduction to medical imaging. Topics to be covered include the physics basics and instrumentation of X-ray CT, PET, SPECT, ultrasound, MRI and Optical Imaging, as well as recent developments in biomedical imaging.

**Credit Hours:** 3  
**Prerequisites:** BIOL_EN 2180 or CV_ENG 7250 (for Chemical Engineering students) or instructor's consent

**BIOL_EN 4350: Watershed Modeling Using GIS**
(same as CV_ENG 4720; cross-leveled with BIOL_EN 7350, CV_ENG 7720). Watershed evaluation using AVSWAT for hydrology, sediment yield, water quality; includes USLE, MUSLE, WEPP. Procedures for model calibration/sensitivity data analysis.

**Credit Hours:** 3  
**Recommended:** BIOL_EN 2180 or CV_ENG 3200 or instructor's consent

**BIOL_EN 4380: Applied Electronic Instrumentation**
 fundamental concepts and theories, basic electronics, analog and digital circuits, signal conditioning, computer interfacing, measurement principles and techniques used in developing computer-based instrumentation systems.

**Credit Hours:** 4  
**Prerequisites:** BIOL_EN 2180 and PHYSCS 2760

**BIOL_EN 4420: Introduction to Biomedical Imaging**
(same as PHYSCS 4420; cross-leveled with BIOL_EN 7420, PHYSCS 7420). This course offers a broad introduction to medical imaging. Topics to be covered include the physics basics and instrumentation of X-ray CT, PET, SPECT, ultrasound, MRI and Optical Imaging, as well as recent developments in biomedical imaging.

**Credit Hours:** 3  
**Prerequisites:** BIOL_EN 2180 or CV_ENG 7250 (for Chemical Engineering students) or instructor's consent

**BIOL_EN 4470: Biomolecular Engineering and Nanobiotechnology**
(same as PHYSCS 4470; cross-leveled with BIOL_EN 7470). Generation of biotechnological products, devices through integration of engineering approaches with contemporary biology, chemistry and nanotechnology starting at the molecular level. Graded on A-F basis only.

**Credit Hours:** 3  
**Prerequisites:** MATH 1700, PHYSCS 2760, CHEM 2100

**Recommended:** MATH 1700, PHYSCS 2760, CHEM 2100

**BIOL_EN 4480: Physics and Chemistry of Materials**
(same as PHYSCS 4190, CHEM 4490, NU_ENG 4319; cross-leveled with BIOL_EN 7480, PHYSIC 7190, CHEM 7490, NU_ENG 7319). Physics and Chemistry of Materials is a 3 credit hours undergraduate/graduate level course offered every spring semester for students from Physics, Chemistry, Engineering and Medical Departments and consists of lectures, laboratory demonstrations, two mid term and one final exam. Graduate students will submit a term paper.

**Credit Hours:** 3  
**Recommended:** PHYSCS 2760 or CHEM 1320 or equivalent
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>BIOL_EN 4570</td>
<td>Fluorescent Imaging</td>
<td>Principles and applications of fluorescent imaging. The course covers: Image formation in microscope; Fundamentals of fluorescence and fluorescent microscopy; molecular and cellular fluorescent imaging.</td>
<td>3</td>
<td>BIO_SC 1500 and BIOL_EN 2180 or instructor's consent</td>
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<td>BIOL_EN 4590</td>
<td>Computational Neuroscience</td>
<td>An interdisciplinary course with a strong foundation in quantitative science for students in biological-behavioral sciences. Graded on A-F basis only.</td>
<td>4</td>
<td>BIO_SC 1010, BIO_SC 1500, MATH 1500</td>
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<td>BIOL_EN 4770</td>
<td>Biomedical Optics</td>
<td>Essential concepts and methods for applying optical techniques to biomedical diagnosis and therapy will be covered with major application examples being discussed.</td>
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<td>BIOL_EN 4940</td>
<td>Engineering Internship</td>
<td>Problem course following prior approved work experience. Problem selected by internship company representative, faculty problem adviser and student. Supervised by faculty problem advisor and presented in engineering report form. Graded on S/U basis only.</td>
<td>1-3</td>
<td>advisor's consent</td>
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<tr>
<td>BIOL_EN 4980</td>
<td>Biological Engineering Design</td>
<td>Design of biological system devices or processes.</td>
<td>3</td>
<td>senior standing or instructor's consent</td>
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<td>BIOL_EN 4980W</td>
<td>Biological Engineering Design - Writing Intensive</td>
<td>Design of biological system devices or processes.</td>
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<td>ENGLISH 1000 and senior standing or instructor's consent</td>
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<td>BIOL_EN 4990</td>
<td>Undergraduate Research in Biological Engineering</td>
<td>Supervised independent study at the undergraduate level.</td>
<td>1-5</td>
<td>instructor's consent</td>
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<td>BIOL_EN 4995</td>
<td>Undergraduate Honors Research in Biological Engineering</td>
<td>Open only to honor students in Biological Engineering. Independent investigation in biological engineering to be presented as a thesis.</td>
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<td>BIOL_EN 4995H</td>
<td>Undergraduate Honors Research in Biological Engineering</td>
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<td>1-5</td>
<td>advisor's consent. Honors eligibility required</td>
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<td>Topics in Biological Engineering</td>
<td>Study of advanced developments in biological engineering.</td>
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<td>BIOL_EN 7250</td>
<td>Irrigation and Drainage Engineering</td>
<td>Soil, water, plant relationships. Water supplies and design of surface, sprinkler and drip irrigation systems. Surface and tile drainage.</td>
<td>3</td>
<td>CV_ENG 3700 or MAE 3400 or BIOL_EN 2180</td>
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<tr>
<td>BIOL_EN 7310</td>
<td>Feedback Control Systems</td>
<td>System modeling and time and frequency response,</td>
<td>3</td>
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closed loop control, stability, continuous system design, introduction to discrete time control, software and hardware experiments on compensator design and PID control. Graded A-F only. May be repeated for credit.

Credit Hours: 3
Prerequisites: MATH 4100

**BIOL_EN 7315: Introduction to Bioprocess Engineering**
(same as CH_ENG 7315; cross-leveled with BIOL_EN 4315, CH_ENG 4315). This general introduction to bioprocess engineering covers the fundamentals of microbiology and biochemistry in the context of a biomass refinery. Analysis proceed through the use of mass balances, energy balances, and empirical or theoretical models.

Credit Hours: 3
Prerequisites: BIOL_EN 2180 (for biological engineering students) or CH_ENG 2225 (for chemical engineering students) or instructor's consent

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(same as CH_ENG 7316; cross-leveled with BIOL_EN 4316, CH_ENG 4316). Design and operation of processes for conversion and/or fractionation of biomass and associated upstream and downstream unit operations. Emphasis on separations and product recovery.

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**BIOL_EN 7350: Watershed Modeling Using GIS**
(same as CV_ENG 7720; cross-leveled with BIOL_EN 4350, CV_ENG 4720). Watershed evaluation using AVSWAT for hydrology, sediment yield, water quality; includes USLE, MUSLE, WEPP, Procedures for model calibration/sensitivity data analysis.

Credit Hours: 3
Prerequisites: BIOL_EN 2180 or CV_ENG 3200 or instructor's consent

**BIOL_EN 7370: Biomolecular Engineering and Nanobiotechnology**
(cross-leveled with BIOL_EN 4470). Generation of biotechnological products, devices through integration of engineering approaches with contemporary biology, chemistry and nanotechnology starting at the molecular level. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: PHYSCS 2760

**BIOL_EN 7470: Biomolecular Engineering and Nanobiotechnology**
(cross-leveled with BIOL_EN 4470). Generation of biotechnological products, devices through integration of engineering approaches with contemporary biology, chemistry and nanotechnology starting at the molecular level. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: PHYSCS 2760

**BIOL_EN 7480: Physics and Chemistry of Materials**
(same as PHYSCS 7190, NU_ENG 7319, CHEM 7490; cross-leveled with BIOL_EN 4480, PHYSCS 4190, NU_ENG 4319, CHEM 7490). Physics and Chemistry of Materials is a 3 credit hours undergraduate/graduate level course offered every spring semester for students from Physics, Chemistry, Engineering and Medical Departments and consists of lectures, laboratory demonstrations, two midterm and one final exam. Graduate students will submit a term paper.

Credit Hours: 3
Prerequisites: PHYSCS 2760 / CHEM 1320 or equivalent/prior approval by instructor

**BIOL_EN 7570: Fluorescent Imaging**
(cross-leveled with BIOL_EN 4570). Principles and applications of fluorescent imaging. The course covers: Image formation in microscope; Fundamentals of fluorescence and fluorescent microscopy; molecular and cellular fluorescent imaging. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIO_SC 1500 and BIOL_EN 2180 or instructor's consent

**BIOL_EN 7590: Computational Neuroscience**
(same as BIO_SC 7590, ECE 7590; cross-leveled with BIOL_EN 4590, BIO_SC 4590, ECE 4590). An interdisciplinary course with a strong foundation in quantitative science for students in biological-behavioral science. Graded on A-F basis only.

Credit Hours: 4
Prerequisites: BIO_SC 1010, BIO_SC 1500, MATH 1500

**BIOL_EN 7770: Biomedical Optics**
(cross-leveled with BIOL_EN 4770). Essential concepts and methods for applying optical techniques to biomedical diagnosis and therapy will be covered with major application examples being discussed.

Credit Hours: 3
Prerequisites: PHYSCS 2760 and BIOL_EN 3180; or instructor's consent

**BIOL_EN 8000: Scientific Discovery Leading to Life Science Innovations**
(same as MPP 8000). The goal of this course is to provide participants with a conceptual and practical understanding of how life science research is conducted in a modern research institution in the US and the pathways involved in translating fundamental discoveries into...
products and services that affect healthcare. We will cover the transitions from initial discovery concepts to first-in-human studies, clinical trials, healthcare guidelines and policy to product development. We will provide an introduction to essential disciplines and interactions that enable scientific discoveries to move forward into novel device and drug therapies. Participants will come away with a very complete picture of how medical research happens, including: how it is funded; what is required to make discoveries and record and protect intellectual property that is created; how to advance innovations to clinical practice, how to navigate the regulatory and bioethical environment, and how discoveries reach practitioners and benefit patients. The Course is the first in a three course sequence leading to a Graduate Certificate in Life Science Innovation and Entrepreneurship. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Must be Graduate Standing or receive certificate program director's approval

BIOL_EN 8001: Advanced Topics in Biological Engineering
Study of advanced developments in biological engineering.
Credit Hour: 1-3

BIOL_EN 8085: Problems in Biological Engineering
Supervised individual study at the graduate level.
Credit Hour: 1-99
Prerequisites: departmental consent

BIOL_EN 8087: Seminar in Biological Engineering
Recent investigations in biological engineering and related fields. Discussion of current literature; preparation and presentation of papers.
Credit Hour: 1

BIOL_EN 8100: Design and Development of Biomedical Innovations
(same as ENGINR 8100). This course takes students through the process of brainstorming and working out a solution to a medical need, and then producing a product. Outputs may include the development of a physical prototype through interactions with the College of Engineering rapid prototype facility. The course is one of a three-course set leading to a Graduate Certificate in Translational Science and Entrepreneurship. Graded on A-F basis only.
Credit Hours: 3
Prerequisites: Student must be enrolled in a graduate degree program and enrolled in a sequenced cohort group beginning with MPP 8000/BIOL_EN 8100 then MANGMT 8200

BIOL_EN 8170: Sensors and Biosensors
The course covers basic principles of chemical and biological sensors, such as immobilization techniques, transducers (optical, electrical, etc.) and performance factors.
Credit Hours: 3

BIOL_EN 8180: Numerical Methods in Engineering Research
Numerical techniques and case studies in Biological Engineering. Topics include basic numerical methods, mathematical representation of data, matrix algebra, ordinary and partial differential equations.
Credit Hours: 3

Prerequisites: MATH 4100

BIOL_EN 8230: Advanced Ceramic Materials
(same as CH_ENG 8230, MAE 8230). To provide an advanced level understanding between processing, properties, and microstructure of ceramic materials. Topics include crystallography, defect chemistry, transport properties, microstructure, and forming methods. Graded on A-F basis only.
Credit Hours: 3

BIOL_EN 8250: Water Management Theory
Advanced studies in erosion control, irrigation, and drainage. Water resources engineering.
Credit Hours: 3
Prerequisites: MATH 1500, Computer Engineering and Computer Science course, SOIL 4307 or SOIL 7307 and Soil Conservation course

BIOL_EN 8280: Advanced Biological Transport Processes
Principles of fluid flow, heat transfer, and mass transfer applied to (a) understanding of how the human body functions (from the cellular up to the system level) and (b) designing biomedical devices. An independent project/case-study of a relevant research topic also required.
Credit Hours: 3

BIOL_EN 8370: Materials Characterization Techniques
Concepts and techniques in characterizing materials, including bulk and surface analyses. Techniques are presented in terms of use, sample requirements, and the engineering principles. Topics include: contact angle measurement, XPS, SEM, TEM, STM, AFM, XRD, and thermal analyses.
Credit Hours: 3
Prerequisites: at least one undergraduate course in material science, engineer, or design

BIOL_EN 8402: Research Methods
(same as F_S 8402). Review of literature; planning research projects; publication procedures.
Credit Hours: 2

BIOL_EN 8470: Ultrasensitive Biodetection
Multiplexing single-molecule, single-cell, nanobiotech analytical techniques to improve disease diagnosis, treatment, and understanding of biophenomena (membrane transport, gene expression, enzyme activities, cell communications). Graded A-F only.
Credit Hours: 3
Prerequisites: Instructor's consent required

BIOL_EN 8570: Microscopic Imaging
Advanced topics in microscopic imaging with focus on applications of molecular and cellular imaging using fluorescent microscopy.
Credit Hours: 3
Prerequisites: BIOL_EN 7570 or instructor's consent
BIOL_EN 8670: Orthopaedic Failure Modes and Effect Analysis
Engineering sciences will be leveraged to provide a comprehensive study of failure modes and related effects for orthopaedic devices, orthopaedic tissue repair, and surgical interventions. Clinical case studies will be analyzed to introduce real-world problems of orthopaedic failures. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIOL_EN 3170 or ENGINR 1200, BIOL_EN 4370 or BIOL_EN 7370 or instructor consent
Recommended: For department majors

BIOL_EN 8870: Molecular and Cell Mechanics
Application of mechanics and engineering principles to biological systems at the cellular and molecular levels. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: ENGINR 2200

BIOL_EN 8990: Masters Thesis Research in Biological Engineering
Independent investigation to be presented as a thesis. Graded on S/U basis only.

Credit Hour: 1-99

BIOL_EN 9990: Doctoral Dissertation Research in Biological Engineering
Independent investigation to be presented as a thesis. Graded on S/U basis only.

Credit Hour: 1-99