

# BIOLOGICAL ENGINEERING (BIOE)

## BIOE 199, SPECIAL TOPICS, 1-16 Credits

*This course is repeatable for 16 credits.*

## BIOE 240, A PRACTICAL INTRODUCTION TO BIOMEDICAL SIGNALS AND SENSORS, 3 Credits

Provides the biophysical basis for several medically-important signals, the operating principles of specific sensors used for acquiring those biomedical signals, and an introduction to signal acquisition, processing, and interpretation in the context of those biosignals. Emphasizes conceptual understanding of these topics through active engagement in group discussions, assembling specific sensor systems using off-the-shelf electronics systems, and use of the sensors to acquire, process, and interpret biosignals.

## BIOE 299, SPECIAL TOPICS, 1-16 Credits

*This course is repeatable for 16 credits.*

## BIOE 340, BIOMEDICAL ENGINEERING PRINCIPLES, 3 Credits

Application of engineering concepts (mass and energy conservation, thermodynamics, and transport phenomena) to cellular- and system-level human physiology; design considerations for biomedical interventions and devices.

**Prerequisite:** BI 231 with C or better and BI 233 (may be taken concurrently) [C] and CBEE 213 (may be taken concurrently) [C] and (CHE 333 (may be taken concurrently) [C] or CHE 333H (may be taken concurrently) [C])

**Recommended:** Completion or concurrent enrollment in BI 233 and (CHE 333 or CHE 333H)

## BIOE 351, BIOMATERIALS AND BIOINTERFACES, 3 Credits

Material interactions with human tissue, with emphasis on the role of interfacial chemistry and physics in cell adhesion, infection, blood coagulation and thrombosis. Preparation of functional hydrogels, material coatings, and derivitizations, including immobilized bio-active molecules. Issues surrounding regulation of implants and device failure.

**Prerequisite:** (BB 451 (may be taken concurrently) with C or better or BB 451H (may be taken concurrently) with C or better) and (CHE 333 (may be taken concurrently) [C] or CHE 333H (may be taken concurrently) [C])

## BIOE 399, SPECIAL TOPICS, 0-16 Credits

**Equivalent to:** BIOE 399H

*This course is repeatable for 16 credits.*

## BIOE 401, RESEARCH, 1-16 Credits

*This course is repeatable for 16 credits.*

## BIOE 403, THESIS, 1-16 Credits

*This course is repeatable for 16 credits.*

## BIOE 405, READING AND CONFERENCE, 1-16 Credits

*This course is repeatable for 16 credits.*

## BIOE 406, PROJECTS, 1-16 Credits

*This course is repeatable for 16 credits.*

## BIOE 407, SEMINAR, 1-16 Credits

*This course is repeatable for 16 credits.*

## BIOE 415, BIOENGINEERING LABORATORY, 3 Credits

Laboratory experimentation with unit operations and processes in bioengineering; preparation of technical reports.

**Prerequisite:** CBEE 414 with C or better

## BIOE 420, SOCIAL JUSTICE, ETHICS, AND ENGINEERING, 3 Credits

Examination of difference, power, and discrimination in engineering education and practice. Lec/rec.

**Prerequisite:** CBEE 320 with C or better

## BIOE 440, BIOCONJUGATION, 3 Credits

Survey of theory and practical current methods for chemical modification and conjugation of proteins and other biomolecules. Topics include permanent and cleavable cross-linkers, protein modification reagents, immobilization of enzymes/DNA, enzyme-antibody conjugates, protein-protein interactions, PEGylation and labeling of proteins, and solid-phase peptide synthesis.

**Prerequisite:** BB 450 with C or better

## BIOE 445, SURFACE ANALYSIS, 3 Credits

The characterization of molecular, biological, and engineered surfaces by modern surface analytical techniques. Topics include surface sensitive modes of electron spectroscopy, vibrational spectroscopy, and mass spectrometry. Students will interpret surface analytical data and gain access to the surface science literature.

**Prerequisite:** BIOE 351 (may be taken concurrently) with C or better

## BIOE 457, BIOREACTORS, 3 Credits

Design and analysis of bioreactors using suspension and immobilized microbial cultures.

**Prerequisite:** (BB 451 with C or better or BB 451H with C or better) and (CHE 333 [C] or CHE 333H [C])

## BIOE 459, CELL ENGINEERING, 3 Credits

Application of engineering methods and principles to the study of mammalian cells. Emphasis on mathematical models of cellular processes (e.g., cellular mass transport, protein-ligand interactions, cellular mechanics) and methods for probing the physical characteristics of biological molecules and cells.

**Prerequisite:** (BB 451 with C or better or BB 451H with C or better) and (CHE 333 [C] or CHE 333H [C])

**Recommended:** BB 451 and CHE 333

**BIOE 462, BIOSEPARATIONS, 3 Credits**

Application of basic mass transfer, reaction kinetics and thermodynamic principles to understanding, selection, and development of strategies for the recovery of products from bioreactors.

**Prerequisite:** (BB 451 with C or better or BB 451H with C or better) and (CHE 333 [C] or CHE 333H [C])

**BIOE 465, BIOMEDICAL IMAGE PROCESSING, 3 Credits**

Explores fundamentals of image formation, enhancement, and analysis for medical and biological applications. Presents common medical imaging and biomedical diagnostic imaging types and resultant format. Provides opportunity to work with real image sets to perform enhancement and analysis operations for the purpose of increasing diagnostic specificity and sensitivity as well as extracting quantitative information.

**Prerequisite:** BIOE 350 with C or better

**BIOE 490, BIOENGINEERING PROCESS DESIGN, 4 Credits**

Engineering economic analysis. Design of bioprocesses: Development of process flow diagrams, equipment sizing, operation, and safety. Quality control and FDA regulations. Lec/rec.

**Prerequisite:** BIOE 415 with C or better and BIOE 457 [C] and BIOE 462 [C]

**BIOE 491, BIOENGINEERING PRODUCT DESIGN, 4 Credits**

Design of biomedical and biotechnology-based products. Applications of a structured design process, meeting customer needs and regulatory considerations to design.

**Prerequisite:** BIOE 490 with C or better

**BIOE 492, BIOENGINEERING CAPSTONE DESIGN, 4 Credits**

Culminating experience in bioengineering design of processes and devices. Includes capstone project prototyping, testing and documentation, and constraints in ethics, intellectual property, standards, regulatory, and manufacturing.

**Prerequisite:** BIOE 491 with C or better

**BIOE 499, SPECIAL TOPICS, 1-16 Credits**

*This course is repeatable for 16 credits.*

**BIOE 503, THESIS, 1-16 Credits**

Graded P/N.

*This course is repeatable for 999 credits.*

**BIOE 507, SEMINAR, 1 Credit**

Graded P/N.

*This course is repeatable for 3 credits.*

**BIOE 511, CELLULAR AND MOLECULAR BIOENGINEERING, 3 Credits**

Fundamentals of mammalian cell biology, with an emphasis on biomedical applications and engineering approaches to study and manipulate cells and tissues.

**Recommended:** A working knowledge of cell biology and biochemistry

**BIOE 512, MODELING OF PHYSIOLOGICAL SYSTEMS, 4 Credits**

Integration of engineering principles and human physiology in the areas of: transport phenomena in the cardiopulmonary and renal systems, bioelectricity in the nervous system, and mechanics of the musculoskeletal system.

**BIOE 513, DRUG AND MEDICAL DEVICE REGULATIONS IN TECHNOLOGY DEVELOPMENT, 2 Credits**

Overview of the processes by which drugs and devices are regulated by the Food and Drug Administration. Topics include drug and device classifications, approval routes for different classes of drugs and devices, current good manufacturing practices, process validation, and quality assurance and control.

*Available via Ecampus*

**BIOE 520, SOCIAL JUSTICE, ETHICS, AND ENGINEERING, 3 Credits**

Examination of difference, power, and discrimination in engineering education and practice. Lec/rec.

**BIOE 540, BIOCONJUGATION, 3 Credits**

Survey of theory and practical current methods for chemical modification and conjugation of proteins and other biomolecules. Topics include permanent and cleavable cross-linkers, protein modification reagents, immobilization of enzymes/DNA, enzyme-antibody conjugates, protein-protein interactions, PEGylation and labeling of proteins, and solid-phase peptide synthesis.

**Recommended:** BB 450

**BIOE 545, SURFACE ANALYSIS, 3 Credits**

The characterization of molecular, biological, and engineered surfaces by modern surface analytical techniques. Topics include surface sensitive modes of electron spectroscopy, vibrational spectroscopy, and mass spectrometry. Students will interpret surface analytical data and gain access to the surface science literature.

**Recommended:** BIOE 351

**BIOE 557, BIOREACTORS, 3 Credits**

Design and analysis of bioreactors using suspension and immobilized microbial cultures.

**Recommended:** (BB 451 or BB 451H) and (CHE 333 or CHE 333H)

**BIOE 562, BIOSEPARATIONS, 3 Credits**

Application of basic mass transfer, reaction kinetics and thermodynamic principles to understanding, selection, and development of strategies for the recovery of products from bioreactors.

**Recommended:** BB 451 and CHE 332

**BIOE 599, SPECIAL TOPICS, 1-16 Credits**

*This course is repeatable for 16 credits.*

**BIOE 603, THESIS, 1-16 Credits**

Graded P/N.

*This course is repeatable for 999 credits.*