

BIOENGINEERING (BENG)

Course Descriptions

BENG 200 Anatomy and Physiology for Engineers 4 Credit Hours

This course introduces undergraduate students in bioengineering to basic concepts in anatomy and physiology. Topics include cell, tissue, nervous, skeletal and muscular, circulatory, respiratory, digestive, endocrine, and urinary systems. Engineering analyses and principles will be used to describe the systems as applicable. Lab sections will be conducted for relevant selected systems. Performance will be assessed based on examinations and laboratory reports. Upon completion of this course, students will have the basic knowledge of anatomy and physiology relevant to bioengineering. (F, W).

Restriction(s):

Can enroll if Level is Undergraduate

Can enroll if College is Engineering and Computer Science

BENG 300 Codes, Standards, and Regulations in Biomedical Engineering 1 Credit Hour

This course provides an overview of the codes, standards, and regulatory frameworks that govern the development and use of biomedical devices, drugs, and laboratory protocols. It introduces the FDA regulatory process, international standards (e.g., ISO, IEC), and legal considerations such as intellectual property and liability. Guest lectures from industry and regulatory bodies supplement core content. A final project challenges students to apply AI tools in developing or interpreting a regulatory application or standard and validating the results. (F, W).

Prerequisite(s): BENG 200

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 325 Thermofluids for Bioengineering 4 Credit Hours

This course is an introduction into mass and heat transport phenomena in biomedical systems. Basic mechanisms of fluid flow, heat transfer, and diffusion are presented and applied to biological objects (cells, tissues, organisms) and biomedical devices. Topics include mass, momentum, and energy conservation laws, physical properties of common and biological fluids, elements of fluid statics, control volume analysis, basics of fluid mechanics, conduction and convection heat transfer, diffusion, applications to hyper- and hypothermia, thermal ablation, and cryopreservation, basics of mass and heat transfer in the body. (YR).

Prerequisite(s): (ENGR 216* or ENGR 200) and ME 230 and (ME 265 or ME 345) and MATH 228*

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 351 Bio-Sensors & Instrumentation 4 Credit Hours

The course covers measurements in biological materials using a variety of sensor technologies along with electronic instrumentation design and use. Safety and FDA requirements are also presented.

Prerequisite(s): (MATH 216 or MATH 228) and BENG 200 and BIOL 140 and ECE 305 and (ENGR 216 or ENGR 200 or ECE 270)

Restriction(s):

Can enroll if Class is Junior or Senior

Can enroll if College is Engineering and Computer Science or Arts, Sciences, and Letters

BENG 364 Prob&Stat in Bioengineering 3 Credit Hours

Set theory, combinatorial analysis, probability and axioms, random variables, continuous and discrete distribution functions, expectations, Chebyshev's inequality, weak law of large numbers, central limit theorem, sampling statistics and distributions, point and interval estimation, and linear regression.

Prerequisite(s): MATH 116 or MATH 114

Restriction(s):

Can enroll if Class is Sophomore or Junior or Senior

Can enroll if College is Engineering and Computer Science

BENG 370 Biomechanics I 4 Credit Hours

The course provides a basic understanding of how the human body functions as a mechanical system. Review of mechanics. Musculoskeletal anatomy, statics and kinematics, muscle force redundancy, joint mechanics. Bone and soft tissue mechanics, muscle active force generation. Implant stress shielding and impact safety. Laboratory experiments directed at rehabilitation engineering, biological bone and tissue property measurement, bone and implant structural analysis, and impact safety.

Prerequisite(s): (ME 265 or ME 345) and (MATH 216 or MATH 228)

Restriction(s):

Can enroll if Program is BSE-Bioengineering

BENG 375 Biomaterial Tissue Engrg 4 Credit Hours

The course provides a basic understanding of the structure, properties and therapeutic applications of biomaterials, as well as the opportunities and scientific and technological challenges of tissue engineering. It also provides an integrated and multidisciplinary biological-engineering approach and probes mechanisms and methods of evaluation of tissue/biomaterials and patient/device interactions. Further the course assesses current outcomes, current challenges and cutting edge technological solutions to medical problems, Laboratory topics include key biological concepts, clinical safety, tissue culture, biological cells/ bioactive materials interaction, and scaffold testing.

Prerequisite(s): ENGR 250 and BIOL 140

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 381 Bioprocessing 4 Credit Hours

This course will introduce the students to the field of bioprocessing where the engineering concepts are applied to convert raw materials to pharmaceuticals, chemicals and food using biological processes. Discussions will include application of bioprocess-engineering knowledge in designing, building, controlling, and operating the biologically driven processes. Typical applications include bioreactor design, material collection and scale-up considerations. The course will also introduce the pharmacokinetics and pharmacodynamics analysis concepts to the students and will serve as an introductory course to teach how to use these concepts to design bioprocess-engineering systems. 4 credit hours (3 credit hours of lecture and 1 credit hour of lab). (YR).

Prerequisite(s): (ME 325 or ME 320 or BENG 325) and BIOL 140 and (CHEM 136 or CHEM 146)

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 410 Bioinformatics 3 Credit Hours

This course covers fundamental computer skills for using various bioinformatics tools, querying bioinformatics databases, computational approaches and analysis methods for biological problems, and introduction to various programming languages and toolboxes for bioinformatics, data mining, and data visualization.

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 425 Transport in Biosystems 3 Credit Hours

This course introduces the principles of transport phenomena (mass, fluid, and heat transfer) in biological and medical systems. Students will develop governing equations and learn analytical approaches to study topics that include but are not limited to biological fluid mechanics and circulation, solute transport in biological systems like cell membranes, transport phenomena in medical devices and artificial organs, and pharmacokinetic analysis. In addition to in-class lectures, the course integrates focused laboratory experiences that cover topics in biotransport phenomena like blood rheology and blood-brain barrier transport. There will also be a journal club presentation at the end of each lecture led by the students.

Prerequisite(s): BENG 325* or ME 371* or ME 375*

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 426 Fundamentals of Drug Delivery 3 Credit Hours

This course is designed to provide students with an understanding on the concepts in drug delivery from an engineering perspective. The course will cover drug delivery mechanisms, quantitative understanding of drug transport, nanotechnology, drug delivery devices, toxicity and immune response, FDA regulations, clinical trials and technology transfer. The course will conclude with a design project on nanoparticles development for targeted drug delivery. (YR).

Prerequisite(s): (BENG 325* or ME 320* or ME 325*)

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 450 Biophotonics and Optical Metrology 3 Credit Hours

The recent explosion of interest in minimally invasive medical diagnostics and contactless metrology has been fueled in part by the development of novel optics and photonics. A large number of optically-based imaging and sensing have moved beyond research laboratories into medical clinics, materials engineering, and industrial applications. Topics include design principles of optical instrumentation, techniques for diagnostics and metrology, and elastic and inelastic light scattering theory. Applications include optical metrology, confocal and multiphoton microscopy, light propagation and tomographic imaging in tissues, and design of minimally invasive spectroscopic systems. Optical systems design is included as a class project. (YR).

Prerequisite(s): PHYS 150 and PHYS 151

Restriction(s):

Can enroll if College is Engineering and Computer Science

Cannot enroll if Major is

BENG 451 Microfluidics 3 Credit Hours

Microscaled systems and devices have enhanced reaction rates, predictable fluid mechanics, reduced reagent volumes, and a cheaper path to rapid prototyping. These advantages benefit many biomedical and processes engineering applications that require sensitive molecular detection and precise flow controls. In this course, a range of microsystem techniques will be discussed, including those based on microfluidics, MEMS, and optofluidics. Lectures will be accompanied by student-driven design projects that will be conducted in 3-hour laboratories. (YR).

Prerequisite(s): (BENG 325* or ME 371* or ME 375*)

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 460 Nanobiosystems Engineering 3 Credit Hours

Nanobiosystems Engineering is an emerging frontier in nanotechnology. It integrates materials science, bioengineering, physics and life science with the biological and biochemical applications. This fast-developing interdisciplinary field holds the promise to solve many of the medical problems of future. The course will introduce advanced concepts related to nanomaterials and nanofabrication and their application in medicine. The course will also focus on design and development of nano-devices for the applications of pharmaceuticals and healthcare. Typical applications include nano-biosensor, targeted drug delivery, and tissue engineering will also be discussed. Students in Bioengineering will have a chance to present and discuss individual application through team project.

Prerequisite(s): (ME 325 or ME 320 or BENG 325) and (ME 349 or BENG 351) and BENG 375

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 4671 Senior Design 4 Credit Hours

A guided design project course where student teams propose design projects, design a device, system or process related to bioengineering and conduct evaluative experiments and/or construct a physical prototype. Engineering ethics and responsibility. At the end of the semester, the students are required to submit written reports and give oral presentations with a demonstration of their projects

Prerequisite(s): BENG 325 and BENG 300 and BENG 351 and BENG 370 and (BENG 375 or BENG 381) and BENG 364

Restriction(s):

Can enroll if Class is Junior or Senior

Can enroll if Major is Bioengineering

BENG 470 Advanced Biomechanics 3 Credit Hours

The course covers intermediate level subject matter on structural biomechanics, analysis and design. Topics include: soft tissue biomechanics, human motion analysis including gait, orthopedic implants, fixation and reconstruction, head impact injury, advanced bone models. (YR).

Prerequisite(s): BENG 370

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 475 Regenerative Engineering 3 Credit Hours

This course will discuss principles of tissue engineering whereby the properties of stem as well as primary cells, growth factors, and extracellular matrix and their impact in the development of engineered tissue constructs will be explored. In addition, the course will also focus on supporting/enabling technologies typically utilized in engineering these constructs including nano- and micro-fabrication techniques, 3D printing, micro-patterning as well as designing principles of bioreactors, and drug and gene delivery techniques. Additionally, various tissue engineering applications will be discussed including synthetic tissues and organs that are currently under development for regenerative medicine application.

Prerequisite(s): (ME 265 or ME 260) and BENG 375

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 480 Mechanotransduction 3 Credit Hours

This course will provide a basic understanding of mechanotransduction and mechanobiology from the perspective of various microenvironments and how the aspects of these microenvironments drive cellular development, homeostasis, health, and disease. Students will learn how to read, interpret, and present information found in research articles as well as design novel bioreactor systems for physiologically relevant microenvironments that recapitulate the major mechanical forces and attributes of particular tissues and diseases. Students will gain group work and presentation experience through the design and presentation of these designs to their classmates. (OC).

Prerequisite(s): (ME 265 or ME 345) and BIOL 140

BENG 481 Biomimetics 3 Credit Hours

The Biomimetic Engineering course will give an overview and in-depth analysis of nature's solutions to specific problems with the aim of determining appropriate engineering analogs. Students will learn mechanical principles in nature and their application to engineering devices. Mechanical behavior of biological materials as governed by underlying microstructure will be discussed. Students will work in teams on projects where they will take examples of designs, concepts and models from biology and determine their potential in specific engineering applications. 3 credit hours (OC).

Prerequisite(s): (ME 325* or ME 320* or BENG 325*)

Restriction(s):

Can enroll if College is Engineering and Computer Science

BENG 490 Directed Design Project 1 to 3 Credit Hours

Design project involving not only design but also analysis, fabrication, and/or testing. Topics may be chosen from any of the areas of bioengineering. The student will need to submit a report on their project at the end of the term. Enrollment in this course requires approval from the ME department. Registration for more than 1 credit is only permitted in special cases and will be considered on an individual basis. (F, S, W).

Restriction(s):

Can enroll if College is Engineering and Computer Science

Cannot enroll if Major is

BENG 492 Guided Study in Bioengineering 1 to 3 Credit Hours

Individual study, design, or laboratory research in a field of interest to the student. Topics may be chosen from any areas of bioengineering. The student will need to submit a report on their project at the end of the term. Enrollment in this course requires approval from the ME department. Registration for more than 1 credit is only permitted in special cases and will be considered on an individual basis. (F, S, W).

Restriction(s):

Can enroll if Class is Senior

Can enroll if Level is Undergraduate

Can enroll if College is Engineering and Computer Science

Can enroll if Major is Bioengineering,

*An asterisk denotes that a course may be taken concurrently.

Frequency of Offering

The following abbreviations are used to denote the frequency of offering: (F) fall term; (W) winter term; (S) summer term; (F, W) fall and winter terms; (YR) once a year; (AY) alternating years; (OC) offered occasionally