BME: BIOMEDICAL ENGINEERING

Courses

BME 110. Introduction to Biomedical Engineering. 3 Credits.
Introduction to the development of biomedical engineering or bioengineering using fundamental concepts and tools from physics, mechanical, chemical, electrical engineering and biology. Topics may include: biomaterials; biomechanics; bioinstrumentation; biotransport and artificial organs; cell and tissue engineering; systems and signals; biochemical engineering; bioelectric phenomenon; and biomeasurements. Additional topics include developing engineering tools for use in advanced courses and problem-solving skills.

BME 120. Introduction to Computer Aided Engineering Design. 3 Credits.
This course introduces students to the modern computational tools used for engineering design and analysis. Topics include: the principles of SolidWorks, simple and advanced part modeling approaches, assembly modeling, drawing, configurations/design tables and surface modeling, the applications of SolidWorks in manufacturing processes, mechanical systems, and engineering analysis.
BME 120 Corequisite: BME 120L.

BME 120L. Introduction to Computer Aided Engineering Design Lab. 0 Credits.
Laboratory studies introducing students to the modern computational tools used for engineering design and analysis. Topics include: the principles of SolidWorks, simple and advanced part modeling approaches, assembly modeling, drawing, configurations/design tables and surface modeling, the applications of SolidWorks in manufacturing processes, mechanical systems, and engineering analysis.
BME 120L Corequisite: BME 120.

BME 199. Biomedical Engineering Transfer Credits. 1-10 Credits.
Transfer Credits
Repeatable for credit.

BME 220. Statics. 3 Credits.
This course covers the application of the principles of mechanics to engineering problems of equilibrium. Topics include resultants, equilibrium, friction, center of gravity, internal forces, analysis of structures, and moment of inertia.
BME 220 Prerequisite: Successful completion of PHY 170, with a minimum grade of D-, and a corequisite or prerequsite of MAT 162.

BME 230. Dynamics. 3 Credits.
This course is to present the fundamentals of particle and rigid body dynamics and to apply these fundamentals to the systematic solution of engineering problems. Topics include: work, energy, and momentum; kinetics and kinematics of a particle; planar and three-dimensional kinematics; and dynamics of rigid bodies.
BME 230 Prerequisite: Successful completion of BME 220 with minimum grade of D-.

BME 310. Engineering Thermodynamics. 3 Credits.
This course introduces students to engineering thermodynamics. Topics include: basic concepts of pure substance; system parameters (temperatures, pressure, etc.); first law and second law of thermodynamics; ideal gas; and equation of the state, work, energy, enthalpy, entropy, and thermal refrigeration cycle.
BME 310 Prerequisite: Successful completion of CHE 104, MAT 162, and PHY 170, with minimum grades of D-.

BME 315. Biomedical Engineering Laboratory I. 2 Credits.
This course introduces student laboratory techniques and tools in biomedical engineering measurement, as well as provides hands-on laboratory experiences. Students will perform a series of laboratory experiments. A project will be conducted at the end of the semester.
BME 315 Prerequisite: Successful completion of BIO 265 and BME 110, with minimum grades of D-. Corequisite: BME 315L.

BME 315L. Biomedical Engineering Laboratory I. 0 Credits.
This course introduces student laboratory techniques and tools in biomedical engineering measurement, as well as provides hands-on laboratory experiences. Students will perform a series of laboratory experiments. A project will be conducted at the end of the semester.
BME 315L Corequisite: BME 315.

BME 320. Biostatistics for Engineers. 3 Credits.
This course introduces students to Biostatistics, covering the basic methods utilized to statistically analyze and present data using R programming language. Students will apply statistical analysis on datasets derived from biomedical engineering studies. Topics include random variables and probability distributions, estimation and confidence intervals, hypothesis testing and statistical inference, one-way ANOVA, two-way ANOVA, one-way repeated-measures ANOVA, and non-parametric tests.
BME 320 Prerequisite: Successful completion of BIO 110 and BME 110, with minimum grades of D-.
Distance education offering may be available.

BME 325. Biomedical Engineering Laboratory II. 2 Credits.
This course is the continuation of BME 315. Students will perform a series of laboratory experiments. A project will be conducted at the end of the semester.
BME 325 Prerequisite: Successful completion of BIO 265, BME 110, and BME 315, with minimum grades of D-. Corequisite: BME 325L.

BME 325L. Biomedical Engineering Laboratory II. 0 Credits.
This course is the continuation of BME 315. Students will perform a series of laboratory experiments. A project will be conducted at the end of the semester.
BME 325L Corequisite: BME 325.

BME 335. Biomaterials. 3 Credits.
This course provides an introduction to the interactions between cells and the surfaces of biomaterials. Topics include: materials commonly used in biomedical applications, chemical structure of biomaterials, physical and mechanical properties of biomaterials, the biocompatibility of those materials with the biological environment, and the immune response to biomaterials.
BME 335 Prerequisite: Successful completion of BIO 265 and CHE 104, with minimum grades of D-.

BME 345. Biotransport Phenomena. 4 Credits.
This course provides the fundamental biomedical applications of fluid mechanics, heat, and mass transfer. Topics include: the principles and applications of biotransport fundamentals, fluid mechanics, macroscopic biotransport, 1-D steady and unsteady state transport, and general multidimensional microscopic transport.
BME 345 Prerequisite: Successful completion of BIO 265, BME 310, and MAT 315, with minimum grades of D-.

BME 355. Biomedical Instrumentation. 3 Credits.
This course is to study the fundamentals of instrumentation in biomedical fields. Topics include: various types of medical instruments; basic analog and digital electronics; data acquisition signal processing; and applications of instrumentation in diagnoses, medical imaging, and laboratory. Regulation and medical safety will be discussed.
BME 355 Prerequisite: Successful completion of BIO 265, MAT 315, and PHY 180, with minimum grades of D-.
Distance education offering may be available.

BME 365. Biomechanics for Engineers. 3 Credits.
In this course, students acquire the basic tools used to analyze the human body as a mechanical system with examples from the tissue level to the whole-body level. Relevant concepts introduced in previous mechanics courses (e.g., BME 230) will be advanced and applied in BME-specific contexts. Topics include the following: joint kinematics and kinetics; linked segment modeling; tissue stresses and strains; and biomechanics related to injury/disease as well as treatments. Emphasis will be placed on how to effectively find, read, interpret, and synthesize the information presented in scholarly research articles to write a literature review and propose a research study.
BME 365 Prerequisite: Successful completion of BIO 265 and BME 230, with minimum grades of D-.
Gen Ed Attribute: Writing Emphasis (select both)
Distance education offering may be available.

BME 410. Senior Design I. 3 Credits.
This is a capstone design course. This course provides students the opportunity to work with real-world, open-ended, and/or interdisciplinary challenges proposed by faculty or industrial project sponsors. Students work as a small team supervised by a faculty member and/or industry advisor. Students team learn and apply principles of engineering, biology, chemistry, physics, and mathematics to solve biomedical engineering problems through the consideration of engineering solutions in global, economic, environmental, and societal contexts. The design process involves: defining functional requirements, conceptualization, design, development, construction, physical prototyping, measurement, analysis, and conclusion. An initial proposal and progress report are required at the beginning of the course as well as in the middle of these two semesters, respectively. A final report and post/oral presentations are required at the end of the second semester.
BME 410 Prerequisite: Successful completion of BME 325, BME 345, BME 355, and BME 365, with minimum grades of D-, or permission of instructor. Corequisite: BME 410L.
Gen Ed Attribute: Speaking Emphasis

BME 410L. Senior Design I Lab. 0 Credits.
This is the laboratory studies component of a capstone design course. This course provides students the opportunity to work with real-world, open-ended, and/or interdisciplinary challenges proposed by faculty or industrial project sponsors. Students work as a small team supervised by a faculty member and/or industry advisor. Students team learn and apply principles of engineering, biology, chemistry, physics, and mathematics to solve biomedical engineering problems through the consideration of engineering solutions in global, economic, environmental, and societal contexts. The design process involves: defining functional requirements, conceptualization, design, development, construction, physical prototyping, measurement, analysis, and conclusion. An initial proposal and progress report are required at the beginning of the course as well as in the middle of these two semesters, respectively. A final report and post/oral presentations are required at the end of the second semester.
BME 410L Corequisite: BME 410.

BME 420. Senior Design II. 3 Credits.
This is the continuation of BME 410. This course provides students the opportunity to work on real-world, open-ended, and possibly interdisciplinary challenges proposed by faculty or industrial project sponsors. Students work as a small team supervised by a faculty member and/or industry advisor. Student teams learn and apply principles of engineering, biology, chemistry, physics, and mathematics to solve biomedical engineering problems through the consideration of engineering solutions in global, economic, environmental, and societal contexts. The design process involves: defining functional requirements, conceptualization, design, development, construction, physical prototyping, measurement, analysis, and conclusion. An initial proposal and progress reports are required at the beginning of BME 410 and in the middle of the two semesters, respectively. A final report and poster and oral presentations are required at the end of BME 420.
BME 420 Prerequisite: Successful completion of BME 410 with a minimum grade of D-.
Corequisite: BME 420L.

BME 420L. Senior Design II Lab. 0 Credits.
This is the continuation of the laboratory studies component of BME 410. This course provides students the opportunity to work on real-world, open-ended, and possibly interdisciplinary challenges proposed by faculty or industrial project sponsors. Students work as a small team supervised by a faculty member and/or industry advisor. Student teams learn and apply principles of engineering, biology, chemistry, physics, and mathematics to solve biomedical engineering problems through the consideration of engineering solutions in global, economic, environmental, and societal contexts. The design process involves: defining functional requirements, conceptualization, design, development, construction, physical prototyping, measurement, analysis, and conclusion. An initial proposal and progress reports are required at the beginning of BME 410 and in the middle of the two semesters, respectively. A final report and poster and oral presentations are required at the end of BME 420.
BME 420L Corequisite: BME 420.

BME 450. Regulatory and GMP. 3 Credits.
This course provides students knowledge of the processes in the manufacture or quality control of biotechnology products with current Good Manufacturing Practices (cGMP) guidelines and regulations. Topics include: introduction to the FDA and other regulatory agencies, current Good Manufacturing Practices (cGMP), process validation requirements and product life cycle quality management, and the application of the regulations to case studies.
BME 450 Prerequisite: Successful completion of BME 325 or permission of instructor, with minimum grade of D-.

BME 455. Bioprocess Engineering. 3 Credits.
This course covers the fundamental principles and applications of bioprocessing. Engineering principles applied to processes involving recombinant protein production are introduced. Emphasis is placed on the engineering aspects of quantitative bioprocess analysis. Topics include bioprocessing, recombinant DNA technology, material balances, mass transfer, bioreactions, and bioreactor engineering.
BME 455 Prerequisite: Successful completion of BME 345, with minimum grade of D-, or permission of the instructor.
Distance education offering may be available.

BME 460. Biomedical Device Design. 3 Credits.
This is a required project-based learning course for Biomedical Engineering (BME) majors. It introduces the engineering design process and related concepts, tools, and methodologies in the context of biomedical device design. Students will work in teams to redesign, modify, fabricate, and validate a current medical device. Topics include the engineering design process, rapid prototyping using 3D printing, finite-element analysis (FEA), and the use of standards in design evaluation (e.g., ASTM testing standards).
BME 460 Prerequisite: Successful completion of BME 120 and BME 365, with minimum grades of D-.

BME 465. Cell and Tissue Engineering. 3 Credits.
This course provides insight into current topics in cell and tissue engineering. Lectures will be supplemented with discussions of current and seminal research topics. Topics include: stem cells/induced pluripotent stem cells and their use in tissue engineering applications, biomaterials and their uses in tissue engineering, and bioreactors for modeling physiologically relevant systems.
BME 465 Prerequisite: Successful completion of BME 335, with a minimum grade of D-, or permission of the instructor.

BME 470. Artificial Organs and Cryobiology Fundamentals. 3 Credits.
This course will introduce students to the multidisciplinary knowledge (in thermodynamics, heat and mass transfer, physical chemistry, biology) and methodologies which are required to study cryobiology and artificial organs. It will also provide cryobiology fundamentals, including a cell's response to low temperature, osmotic behavior, and membrane transport at low temperature and activation energy, mechanisms of cryoprotection, and the fundamentals of kidneys and hemodialysis, including type of kidney diseases, different treatments, and kinetic modeling in hemodialysis.
BME 470 Prerequisite: Successful completion of BME 345, with a minimum grade of D-, or permission of the instructor.