BME Biomedical Engineering

#BME 170 HUMAN ANATOMY FOR DESIGN. (3)

Explores the structure and function of the human body to facilitate understanding of the body's interface with product design. Bone, muscle, neural, circulatory, and digestive systems will be studied and considered with respect to product design-oriented tasks such as mobility, seating, physical tasks, digital and electronic interactions, etc. The course will delve into physiological themes, such as how structure and function are closely related and the need for product designers to consider the two-way flow of information/interactions from body to product and product to body, and the effects of each on product and human function. This course is part of a sequence of courses that advances in complexity over 5 semesters, and it establishes the foundation for advanced coursework in ergonomics, materials, user interface, and user experience design. (Same as PRD 170.)

*BME 201 INTRODUCTION TO BIOMEDICAL ENGINEERING. (3)

Survey of the principles, practices, sub-specialty areas, and careers in biomedical engineering. Prereq: BIO 148, CHE 105, MA 113, PHY 231, PHY 241.

BME 301 FUNDAMENTALS OF BIOMEDICAL ENGINEERING. (3)

Overview of the application of engineering principles to problems in living systems and healthcare delivery. Fundamental anatomy and physiology for engineers. Quantitative measurement and analysis of the structure, function, and control of biological systems. Prereq: Engineering standing or consent of instructor.

#BME 302 DESIGN STRATEGIES FOR BIOMEDICAL ENGINEERING. (3)

Survey of biomedical engineering foundations and constraints. Terminology, anatomy/biology/physiological, engineering/math/science/statistics essentials, engineering constraints imposed by financial, regulatory, governing agencies, and strategies for successful biomedical engineering practice. Prereq: BME 201.

#BME 330 EXPERIMENTAL METHODS IN BIOMEDICAL ENGINEERING. (3)

This course reviews the fundamental scientific principles in biomedical instrumentation, links these principles to key engineering parameters quantifying metrics of human wellness, and introduces students to the instrumentation permitting empirical measurement of these parameters. Lectures supplemented with laboratory experiences. Prereq: BME 201 and engineering standing or consent of instructor.

#BME 350 MATERIALS AND PROCESSES. (3)

A survey of current materials, processes, techniques and equipment used in the design of products for mass production. A significant portion of the design process is devoted to manufacturing questions – how materials are selected, shaped, and then assembled. Structure, properties and function of metals, polymers, ceramics, and biological materials will be covered. This course will include field visits to manufacturing facilities. (Same as PRD 350.)

#BME 371 ERGONOMICS. (1)

This course is supplemental to PRD 320 Product Design Studio III and discusses advanced concepts of ergonomics with respect to product design. Students will create 2D and 3D studies of situations requiring a diagrammatic understanding of human factors and ergonomic issues. Students will learn how to conduct a range of usability tests to evaluate and improve ergonomic conditions. Projects from PRD 321 and other studio courses within the College of Design will serve as case studies for analysis and application of course content. The course is part of a sequence of courses that advance in complexity over 5 semesters, stemming from PRD/BME 271, Intro to Ergonomics, and takes the concept of ergonomics a step further into dynamic product components. It is third in a sequence of courses specifically focused on ergonomics. Prereq: PRD/BME 271. (Same as PRD 371.)

#BME 372 UX + UI FOR PRODUCT DESIGN. (1)

This course is supplemental to PRD 321 Product Design Studio III and introduces principles and methodologies of user interface and interaction design as critical elements of user experience design. Students will create interaction diagrams and develop prototypes for products and/or services. Students will learn and apply principles of visual communication, typography and motion design to create visually appealing, intuitive and feedback-based user interfaces. Students will learn how to conduct a range of usability tests to evaluate and improve interface designs. Projects from PRD 321 and other studio courses within the College of Design will serve as case studies for analysis and application of course content. This course is part of a sequence of courses that advances in complexity over 5 semesters, and it is the second of two parts focusing on user interface and user experience design. As part of this course, students may participate in field trips to sites, businesses, manufacturers, etc. to further their knowledge of the design profession and coursework, sometimes with corresponding entry fees. Prereq: PRD 272. (Same as PRD 372.)

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BME 395 INDEPENDENT RESEARCH IN BIOMEDICAL ENGINEERING. (1-3)
Individual research on selected problems of current significance in biomedical engineering. Variable credit; may be repeated to a maximum of six credit hours. Prereq: Consent of instructor.

BME 405 INTRODUCTION TO BIOMEDICAL SIGNAL PROCESSING. (3)
Study of continuous and discrete signal concepts, sampling of analog signals, domain transformation (Fourier, LaPlace, Z-Transforms), and introduction to correlation and power spectrum. Characteristics and design of analog and digital filters. Features of biological signals and systems and biomedical applications. Introduction to non-linear systems. Prereq: EE 305 or equivalent and MA 214; or consent of instructor.

#BME 420 SENIOR DESIGN PROJECT IN BIOMEDICAL ENGINEERING I. (3)
First semester of a two-semester degree-program capstone biomedical engineering design project. This project involves team-based application of basic science, foundational engineering, biomedical engineering, personal management and communication skills to actual industrial product, process, or material developments aimed at solving a real contemporary human healthcare challenge. Prereq: Senior class standing for declared biomedical engineering majors or consent of instructor.

#BME 421 SENIOR DESIGN PROJECT IN BIOMEDICAL ENGINEERING II. (3)
This course is the continuation of BME 420 and requires students to engage with industry representatives to provide substantive new engineering solutions to practical current healthcare challenges. Prereq: BME 420 or consent of instructor.

#BME 435 COMPUTER MODELING OF COMPLEX SYSTEMS. (4)
A holistic approach to engineering problems using computer modeling. Lectures exemplified by real-world problems governed by combined mechanical, electrical, thermal, electrochemical and mass-transport phenomena addressed in an integrated and multidisciplinary manner. Prereq: MA 214 or equivalent or consent of the instructor.

#BME 451 INTEGRATED ENTREPRENEURSHIP IN PRODUCT DESIGN. (2)
This course focuses on the relationship between design and entrepreneurship: exploring basic business vocabulary and how design vocabulary and design processes overlap, complement and enhance business operations and opportunities, interact with new venture funding partners, and business plan design and preparation. The organization of the course focuses on assembling multidisciplinary teams to engage in the process of bringing a product to market, building a business concept around a core competency in design, the structure of a design office, the development and protection of intellectual property, and the development of a cogent business plan. The course works in parallel with PRD 420 (Integrated Studio), using projects from this studio as case studies. Intrinsic points of discussion include: design project management, project organization and leadership and start-up protocol. Prereq: Senior standing or permission of instructor.. (Same as PRD 451.)

BME 472 HUMAN BIOMECHANICS. (3)
This course presents an engineering-based approach to the quantitative study of the human musculoskeletal system. Principles involving static and dynamic mechanical analyses will be applied to quantify the forces and moments in human posture and movement. Study of the material and biological properties of the musculoskeletal system is included because they are intimately coupled to the formulation and interpretation of problems in static and dynamic biomechanics. Prereq: EM 221, EM 313; or consent of instructor.

BME 481G TOPICS IN BIOMEDICAL ENGINEERING. (3)
Detailed investigation of a topic of current significance in biomedical engineering such as: biomaterials, hard or soft tissue biomechanics, rehabilitation engineering, cardiopulmonary systems analysis, biomedical imaging. Prereq: Consent of instructor.

BME 485 FUNDAMENTALS OF BIOFLUID MECHANICS. (3)
This course is taught concurrently with BME 685 Biofluid Mechanics. This course provides the students with a review of basic fluid mechanics principles and a direct, practical application of these principles to biomedical and clinical problems associated with the human circulatory system. Prereq: Engineering standing or consent of instructor.

BME 488 INTRODUCTION TO BIOMATERIALS. (3)
Study of biological and man-made materials that perform, improve, or restore natural functions. Structure and properties of connective tissue and commonly implanted metals, ceramics, and polymers; biocompatibility of materials used in orthopedic, soft tissue, and cardiovascular applications. Prereq: Engineering standing and MSE 201; or consent of instructor.

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BME 501 FOUNDATIONS OF BIOMEDICAL ENGINEERING. (3)
This course demonstrates the application of diverse engineering principles to analysis and understanding of the structure, function, and control of biological systems. Quantitative measurements and analysis of homeostatic, regulatory, transport, biochemical, and biomechanical processes of the human body. Prereq: Engineering standing or consent of instructor.

BME 508 CELL MECHANICS AND MECHANOBIOLOGY. (3)
This course will serve as an introduction to cell and tissue level mechanobiology with focus on human physiological and disease processes. The primary focus is to introduce principles of cell-level mechanics in the context of the biology of living organisms, what we term mechanobiology. In effect, we treat biological processes and regulation as another variable(s) that must be accounted for when modeling the mechanical/physical behavior of human tissues. A large amount of the basic principles in this field of study arose as a result of the intense research in the cardiovascular field. We will draw many examples of mechanobiological principles as it relates to the circulatory system. Despite our cardiovascular focus, the basic principles can be applied to the whole range of mechanobiological research conducted in other applications (orthopedics, urological, pulmonary, etc.). Prereq: EM 302 and/or CME/ME 330 (or equivalent fluid mechanics course); or consent of instructor.

BME 515 MODELING OF PHYSIOLOGICAL SYSTEMS. (3)
This introductory course in mathematical modeling will teach students how to construct simple and elegant models of biological and physiological processes – for instance the absorption and elimination of drugs in the human body or the kinetics of tumour growth in tissue – and to analyze or predict the dynamics of these events by solving the models. Prereq: MA 113, 114, 213, 214, or consent of instructor; familiarity with computer programming.

BME 530 BIOMEDICAL INSTRUMENTATION. (3)
A comprehensive introduction to major aspects of biomedical instrumentation. Topics include basic concept of medical instrumentation, biopotentials, physiological pressure/flow/respiratory measurement, optical sensing, and clinical applications of all the above. The fundamental mathematics underlying each instrument will be reviewed and an engineering picture of the hardware and software needed to implement each system will be examined. Prereq: Consent of instructor.

BME 540 MECHANICAL MODELING OF HUMAN MOTION. (3)
An introduction to mechanical modeling of human motion (lectures) along with application of computational software to model and estimates internal tissues responses to physical demands of several different activities/tasks (lab activities). Prereq: EM 221, EM 313; or consent of instructor.

BME 541 OCCUPATIONAL BIOMECHANICS. (3)
This course will provide an understanding of physical interaction between workers and their tools, machines, and materials so as to enhance the workers performance while minimizing the risk of musculoskeletal disorders. Discussion of ergonomic methods for measurement, assessment, and evaluation, with major topics including manual materials handling, cumulative trauma disorders, environmental stresses, safety, and legal issues. Prereq: Engineering standing or with instructor permission. (Same as MFS 541.)

*BME 579 NEURAL ENGINEERING: MERGING ENGINEERING WITH NEUROSCIENCE. (3)
A multidisciplinary approach combining engineering principles for systems analysis and control, knowledge of biological control mechanisms, and computational properties of biological neural networks in the development of engineering neural networks for control applications. Topics include: equivalent circuit models for biological neurons and networks, non-linear differential equation representations, biological control strategies for rhythmic movements, design and development of controller for robot function, proposal development and presentation. Prereq: Engineering Standing or consent of instructor. (Same as EE 579.)

BME 580 INTRODUCTION TO BIOMEDICAL IMAGING. (3)
A comprehensive introduction to bio-medical imaging systems used today, including xray imaging and computed tomography (CT), magnetic resonance imaging (MRI), ultrasound imaging (UI), and diffuse optical tomography (DOT). The course will review the fundamental mathematics underlying each imaging modality, the hardware needed to implement each system, and the image reconstruction and analysis. The class may involve homework, projects, and exams. Prereq: EE 305, or consent of instructor.

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BME 599 TOPICS IN BIOMEDICAL ENGINEERING (Subtitle required). (3)
An interdisciplinary course devoted to detailed study of a topic of current significance in biomedical engineering, such as cellular mechanotransduction, systems biology, and tissue engineering. May be repeated to a maximum of six credits. Prereq: Consent of instructor.

BME 605 BIOMEDICAL SIGNAL PROCESSING I. (3)
Continuous and discrete signals, sampling, Fourier Transform, LaPlace Transform, Z-Transform, correlation and spectral analysis, digital filters. Prereq: Concurrent enrollment or completion of PGY 412G or PGY 502.

BME 610 BIOMEDICAL CONTROL SYSTEMS I. (3)
Homeostatic mechanisms, input-output analysis, steady state and transient response, feedback concepts, system identification and simulation from actual operating data. Prereq: PGY 502 and ME 440 or equivalent.

BME 615 BIOMEDICAL SIGNAL PROCESSING II. (3)
Stochastic processes, Fourier-based spectral analysis and linear system identification, modern spectral estimation (AR, MA, ARMA), parametric transfer function estimation, time-frequency analysis of nonstationary signals. Prereq: BME 605, BME 610, EE 640 recommended.

BME 640 BIOMEDICAL ENGINEERING ETHICS. (1)
This course presents an engineering-based approach to study the system of ethics applicable to biomedical engineering. This course will describe and examine the responsibilities of biomedical engineers to stakeholders, e.g., patients, research subjects, and engineering clients as well as to the legal system (where applicable) and the profession as an entity. As a scholarly discipline, biomedical engineering ethics draws upon principles from subjects such as: the philosophy of science, the philosophy of engineering, and the ethics of technology. Materials from these principles will be used in this course with adaption to the special circumstances attending the practice of Biomedical Engineering.

BME 642 NAVIGATIONAL GUIDES FOR BIOMEDICAL PRODUCT DEVELOPMENT. (3)
This course teaches engineers how biomedical product designs are influenced by government regulations, economic issues, and ethical concerns.

BME 661 BIOMATERIALS SCIENCE AND ENGINEERING. (3)
Study of biological and man-made materials that perform, improve, or restore natural functions. Structure and properties of connective tissue and commonly implanted metals, ceramics, and polymers; biocompatibility of materials used in orthopedic, soft tissue, and cardiovascular applications. Prereq: Undergraduate engineering degree or consent of instructor.

BME 662 TISSUE-IMPLANT INTERFACE. (3)
Study of the interface between implants and host tissues from both the materials and biological perspective. Structure of the tissue-implant interface; surface characterization of biomaterials; protein adsorption; mechanisms of cell responses; the methods for controlling the tissue-implant interface, with emphasis on orthopedic and cardiovascular applications. Prereq: BME 661 or consent of instructor.

BME 670 BIOSOLID MECHANICS. (3)
Application of laws of mechanics to study the behavior of human organ systems. Stress-strain analysis of soft and hard body tissues with emphasis on pulmonary and musculoskeletal systems. Viscoelastic properties. Prereq: Undergraduate engineering degree or consent of instructor.

BME 672 MUSCULOSKELETAL BIOMECHANICS. (3)
Application of laws of mechanics to study behavior of human musculoskeletal system. Materials science of bone, muscle, tendon are integrated into static and dynamic analyses of isolated (e.g., foot, arm, and hand) and whole body segment. Prereq: PGY 502, ME 330 or consent of instructor.

BME 685 BIOFLUID MECHANICS. (3)
Review of the rheology of circulatory processes in the body. Special emphasis on cardiovascular dynamics: pulsatile pressure and flow, vascular impedance, wave propagation/reflection, cardiac dynamics. Special topics. Lecture, three hours with periodic lab demonstrations. Prereq: Undergraduate engineering degree or consent of instructor.

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BME 690 RESEARCH IN BIOMEDICAL ENGINEERING (Subtitle required). (1-3)
Individual study related to a special research project. Intended for M.S. candidates who want a research project experience independent of their M.S. thesis work. This course cannot be used to satisfy residency credit requirements. Lecture, 1-3 hours; laboratory, 3-6 hours per week. May be repeated to a maximum of six credits. Prereq: Consent of instructor and graduate standing in BME.

BME 699 SPECIAL TOPICS IN BIOMEDICAL ENGINEERING (Subtitle required). (1-3)
Special topics in biomedical engineering, addressed primarily in a lecture/discussion format. Presentation of focussed or specialized topics that are not available in standard courses. Lecture, three hours; laboratory 0-2 hours per week. May be repeated to a maximum of nine credits. Prereq: Consent of instructor and graduate standing in BME.

BME 748 MASTER'S THESIS RESEARCH. (0)
Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.

BME 749 DISSERTATION RESEARCH. (0)
Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams.

BME 766 MANAGEMENT OF TECHNOLOGY. (3)
Successfulness in developing new technologies relies upon knowing which technology advance, the ultimate scientific limits of that technology, and the forecasted rate of technological change. This course presents curricula that explore the direction of technological change and how this affects the rate and extent of innovation.

BME 767 DISSERTATION RESIDENCY CREDIT. (2)
Residency credit for dissertation research after the qualifying examination. Students may register for this course in the semester of the qualifying examination. A minimum of two semesters are required as well as continuous enrollment (Fall and Spring) until the dissertation is completed and defended.

BME 768 RESIDENCE CREDIT FOR THE MASTER'S DEGREE. (1-6)
May be repeated to a maximum of 12 hours.

BME 769 RESIDENCE CREDIT FOR THE DOCTOR'S DEGREE. (0-12)
May be repeated indefinitely.

BME 772 SEMINAR. (0)
Review of current literature in the field of biomedical engineering, general discussion and presentation of papers on research in biomedical engineering. Lecture, one hour per week. Required for all graduate students in biomedical engineering.

BME 774 GRADUATE BME SEMINAR. (0-1)
Scientists and engineers present current research in biomedical engineering. Students are required to prepare for and deliver a seminar on their own research. May be repeated to a maximum of 4 credits. Prereq: Graduate standing in Biomedical Engineering or consent of instructor.

BME 777 ADVANCED STUDY PROJECT. (3)
This is an independent study project, topic to be selected in consultation with the instructor. Purpose is to integrate all materials learned in the program and apply these principles to the solution of an actual problem in biomedical engineering technology. Prereq: Permission of instructor and completion of year 1 PBME studies.

BME 781 SPECIAL PROBLEMS IN BIOMEDICAL ENGINEERING (Subtitle required). (1-3)
Discussion of advanced and current topics in biomedical engineering. Individual work on research problems of current interest. May be repeated to a maximum of nine credits. Lecture/laboratory hours, variable. Prereq: Approval of instructor.

BME 790 RESEARCH IN BIOMEDICAL ENGINEERING. (1-9)
Graduate research in any area of biomedical engineering, subject to approval of the Director of Graduate Studies. May be repeated to a maximum of nine hours. Prereq: Consent of the Director of Graduate Studies.