BMEN - BIOMEDICAL ENGINEERING

BMEN 604 FDA Good Laboratory and Clinical Practices

Credits 3. 3 Lecture Hours. Implementation of Good Laboratory Practices (GLP) for the submission of preclinical studies and use of Good Clinical Practices (GCP) in clinical trials in accordance with Food and Drug Administration (FDA) regulations; includes similarities and differences in GLP and GCP critical for the introduction of new drugs and medical devices. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 606 Medical Device Path to Market

Credits 3. 3 Lecture Hours. Path to market for a medical device with specific attention to the regulatory affairs to enable the development of an appropriate regulatory strategy due to the highly regulated global environment. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 608 Biophotonics II

Credits 3. 3 Lecture Hours. Photon transport in tissue; photon scattering and absorption; Mie scattering; Monte Carlo; optical spectroscopy, including absorption, fluorescence, and Raman scattering; multiphoton processes; plasmonics. **Prerequisite:** BMEN 625 or approval of instructor.

BMEN 613 Principles and Analysis of Physiological Control Systems

Credits 3. 3 Lecture Hours. Techniques for generating quantitative mathematical models of physiological control systems and devices; the behavior of physiological control systems using both time and frequency domain methods. **Prerequisites:** Graduate classification or approval of instructor.

BMEN 622 Bioelectromagnetism

Credits 3. 3 Lecture Hours. Electric, magnetic and electromagnetic phenomena in association with biological tissues; source modeling based on physiological current including line and volume conductor models as well as electromagnetic-based stimulation, sensing and imaging. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 625 Biophotonics

Credits 3. 3 Lecture Hours. Theory and application of optical instrumentation, including light sources, lasers, detectors, and optical fibers; instrumentation and engineering in biomedical applications of optics in therapeutics, diagnostics, and biosensing. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 627/ECEN 763 Magnetic Resonance Engineering

Credits 3. 2 Lecture Hours. 3 Lab Hours. Design, construction and application of instrumentation for MR imaging; fundamentals of the architecture of an MR spectrometer and the gradient subsystem used for image localization; emphasis on the radiofrequency sensors and systems used for signal generation and reception. **Prerequisites:** BMEN major; graduate classification or approval of instructor. **Cross Listing:** ECEN 763/BMEN 627.

BMEN 628 Embedded Systems for Medical Applications

Credits 3. 2 Lecture Hours. 3 Lab Hours. Principles of embedded system architecture and programming; fundamentals and theoretical foundations of wireless communication systems; hands-on experiences of how an embedded system could be used to solve problems in biomedical engineering; projects on wireless sensors and imaging for medical devices. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 631 Biomolecular Engineering

Credits 3. 3 Lecture Hours. Foundations for understanding the experimental approaches for measuring and manipulating biomolecules; proteins, nucleic acids, and carbohydrates; thermodynamics and kinetics of biomolecular reactions. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 632 Molecular and Cellular Biomechanics

Credits 3. 3 Lecture Hours. Introduces biomolecules and their assemblies that play structural and dynamical roles in subcellular to cellular level mechanics, with emphasis on quantitative/theoretical descriptions, and discussions of the relevant experiment approaches to probe these nano to micro-scale phenomena; including topics in (1) self-assembly of cytoskeleton and biomembranes, (2) molecular motors, (3) cell motility, and mechanotransduction. **Prerequisites:** Graduate classification or approval of instructor.

BMEN 635 Biomaterials Compatibility

Credits 3. 3 Lecture Hours. Relevance of mechanical and physical properties to implant selection and design; effect of the body environment on metallic, ceramic and plastic materials; tissue engineering; rejection mechanisms used by the body to maintain homeostasis regulatory requirements. **Prerequisites:** Approval of instructor.

BMEN 636 Pathophysiology of Systemic Diseases Augmented with Implantable Devices

Credits 3. 3 Lecture Hours. Clinical presentation of patients with systemic diseases and the pathophysiologic interrelationship with therapeutic implantable devices; processes of inflammation/repair as it applies to challenges of therapeutic augmentation with implantable devices; systems covered include cardiovascular, central nervous system, eye, dental, gastrointestinal, musculoskeletal, endocrine, reproductive/urogenital, skin/soft tissue; implantable device intervention as a therapeutic adjunct in systemic diseases. **Prerequisites:** Graduate classification or approval of instructor.

BMEN 637 Pathological Basis of Implantable Devices

Credits 3. 3 Lecture Hours. The relationship that clinical presentation has for patients with primary heart disease; focus on general categories of inflammation and repair, systemic pathology emphasis on cardiovascular disease and the importance elucidated on implantable device intervention as a therapeutic adjunct in heart disease. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 641 Numerical Methods in Biomedical Engineering

Credits 3. 3 Lecture Hours. Application of numerical analysis to analyze molecular, cellular and physiological systems; general techniques used to analyze steady and dynamic systems; techniques will be applied in a MATLAB programming environment. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 642 Mass and Energy Transfer in Biosystems

Credits 3. 3 Lecture Hours. Understanding the transport phenomena associated with physiological systems and their interaction with medical devices; exchange processes in artificial life support systems and diagnostic equipment. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 643 Risk Based Development and Testing of Medical Devices

Credits 4. 2 Lecture Hours. 6 Lab Hours. Focus on the detailed design and development phases of the design innovation process for healthcare applications; includes medical device development projects in which teams will work on innovative medical devices that progressed through the concept phase of the development life cycle; includes detailed design and development, risk based design process, including the conduct of hazards analysis, design FMEA, application FMEA, process FMEA, device manufacturing, device testing and FDA design verification and validation. **Prerequisite:** Enrolled in master of engineering in biomedical engineering; graduate classification or approval of instructor.

BMEN 650 Biomedical Optics Laboratory

Credits 3. 2 Lecture Hours. 3 Lab Hours. Biomedical optics technology; basic engineering principles used in developing therapeutic and diagnostic devices; a series of hands-on labs will be performed including optical monitoring, diagnostic and therapeutic experiments. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 657 Orthopedic Biomechanics

Credits 3. 3 Lecture Hours. Fundamental course in orthopedic biomechanics designed to develop competencies in biomechanical principles using practical examples and clinical case studies of how biomechanical knowledge is applied to the evaluation of musculoskeletal tissues and structures, and treatment options for musculoskeletal dysfunction. **Prerequisite** (s): Admitted into the major degree sequence in Biomedical Engineering and graduate classification.

BMEN 658 Motion Biomechanics

Credits 3. 3 Lecture Hours. Skeletal anatomy and mechanics; muscle anatomy and mechanics; theory and application of electromyography; motion and force measuring equipment and techniques; inverse dynamics modeling of the human body; current topics in musculoskeletal biomechanics research. **Prerequisites:** Graduate classification or approval of instructor.

BMEN 661 Cardiac Mechanics

Credits 3. 3 Lecture Hours. Application of continuum mechanics and computational solid mechanics to the study of the mammalian heart; utilization of continuum mechanics and finite element analysis in solving non-linear boundary value problems in biomechanics. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 663 Soft Tissue Mechanics and Finite Element Methods

Credits 3. 3 Lecture Hours. Application of continuum mechanics and finite element methods to the study of the mechanical behavior or soft tissues and associative applications in biomedicine. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 669 Entrepreneurial Pathways in Medical Devices

Credits 3. 3 Lecture Hours. Overview of fundamental elements and development steps for an effective strategy pathway including regulatory pathway for commercialization of medical product/medical device innovations; application of the basic regulations and associated requirements and enforcements for product market approval; exploration of product quality test method design requirements; understanding of the applicable regulations and standards pertaining to the design, testing, approval and marketing of medical devices. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 674 Communications in Biomedical Engineering

Credits 3. 3 Lecture Hours. General concepts for communicating the results of biomedical research including written papers, conference proceedings, proposals and grants, as well as oral presentations and basic ethics. **Prerequisite:** Approval of instructor.

BMEN 675 Biomedical Case Studies

Credit 1. 1 Lecture Hour. Introduction to the engineering design process for solving biomedical problems by using the case study method in biomedical instrument design. **Prerequisite:** Approval of instructor.

BMEN 676 Professional Development for Biomedical Engineering

Credits 2. 2 Lecture Hours. Advanced concepts in professional interactions including oral and written communications; skills related to interviewing and obtaining job offers and understanding employment compensation and benefits; professional ethics. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 680 Biomedical Engineering of Tissues

Credits 3. 3 Lecture Hours. Introduction to engineering strategies used to repair tissue; literature-grounded overview of current strategies using stem cells, 3D scaffolds and drug/gene delivery including ethical considerations of these therapies. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 681 Seminar

Credit 1. 1 Lecture Hour. Designed to permit student to broaden capability, performance and perspective in biomedical engineering via his or her own formal presentation and by presentations from other professionals. **Prerequisite:** Approval of instructor.

BMEN 682 Polymeric Biomaterials

Credits 3. 3 Lecture Hours. Preparation, properties, and biomedical applications of polymers including polymerization; structure-property relationships; molecular weight and measurement; morphology; thermal transitions; network formation; mechanical behavior; polymeric surface modification; polymer biocompatibility and bioadhesion; polymers in medicine, dentistry, and surgery; polymers for drug delivery; polymeric hydrogels; and biodegradable polymers. **Prerequisites:** Graduate classification or approval of instructor.

BMEN 683 Polymeric Biomaterial Synthesis

Credits 3. 3 Lecture Hours. Overview of polymer synthetic routes and key structure-property relationships with emphasis on the design of polymeric systems to achieve specific properties; tissue engineering and drug delivery applications will be used as model systems to explore the process of biomaterial design from synthesis to device evaluation. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 684 Professional Internship

Credits 1 to 12. 1 to 12 Other Hours. Training under the supervision of practicing engineers in settings appropriate to the student's professional objectives. **Prerequisites:** Approval of chair of student's advisory committee and department head.

BMEN 685 Directed Studies

Credits 1 to 12. 1 to 12 Other Hours. Allows students the opportunity to undertake and complete, for credit, limited investigations not included within thesis or dissertation research and not covered by other courses. May be repeated for credit. **Prerequisites:** Approval of designated instructor and approved project proposal.

BMEN 686 Biomedical Nanotechnology

Credits 3. 3 Lecture Hours. Introduction to nanotechnology applications in biomedicine; concepts of scale; unique properties at the nanoscale; biological interaction, transport, and biocompatibility of nanomaterials; current research and development of nanotechnology for medical applications, including sensors, diagnostic tools, drug delivery systems, therapeutic devices, and interactions of cells and biomolecules with nanostructured surfaces. **Prerequisite:** Graduate classification or approval of instructor.

BMEN 687 Drug Delivery

Credits 3. 3 Lecture Hours. Mechanisms for controlled release of pharmaceutically active agents and the development of useful drug delivery systems; controlled release mechanisms including diffusive, convective and erosive driving forces by using case studies related to oral, topical and parenteral release in a frontier interdisciplinary scientific research format. **Prerequisite:** Graduate classification in biomedical engineering or approval of instructor.

BMEN 689 Special Topics in...

Credits 1 to 4. 1 to 4 Lecture Hours. 0 to 4 Lab Hours. Selected topics in an identified area of biomedical engineering. May be repeated for credit. **Prerequisite:** Approval of instructor.

BMEN 691 Research

Credits 1 to 23. 1 to 23 Other Hours. Research for thesis or dissertation.