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 605 Virtual Instrumentation Design for Medical Systems
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Design of medical systems using graphics programming language of LabVIEW including the designing and programming of three virtual systems: cardiac monitor, electromyogram system for biomechanics, and sleep stage analyses for electroencephalograms.
Prerequisite: 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 607 Clinical Engineering
Credits 3. 3 Lecture Hours.
Responsibilities, functions and duties of the hospital based biomedical engineer including program organization, management, medical equipment acquisition and use, preventive maintenance and repair and hospital safety.
Prerequisite: 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 609 Optical Therapeutic and Interventional Principles
Credits 3. 3 Lecture Hours.
Study of mechanical and thermal processes of radiation interaction with biological tissue; issues and objectives in therapeutic, surgical, and diagnostic applications; basic engineering principles used in developing therapeutic with a focus on the use of lasers and optical technology.
Prerequisites: MATH 308; PHYS 208.

BMEN 611 Biomedical Imaging Systems
Credits 3. 3 Lecture Hours.
The physics behind the major medical imaging systems including CT, MRI, Ultrasound and X-Ray will be introduced and described; a linear systems approach will be used along with basic diffraction theory.
Prerequisites: BMEN 322; MATH 308.

BMEN 620 Bi-Optical Imaging
Credits 3. 3 Lecture Hours.
Optical imaging techniques for detection of structures and functions of biological tissues; basic physics and engineering of each imaging technique.
Prerequisite: MATH 308.

BMEN 621 Microscale Bio-Optical Applications
Credits 3. 3 Lecture Hours.
Introduction to the biomedical application of lasers to manipulation, detection and visualization on (sub)cellular length scales, with emphasis on governing principles on which applications are founded; applications from recent literature (state-of-the-art) presented.
Prerequisites: 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 624 Biomedical Sensing and Imaging at the Nanoscale
Credits 3. 3 Lecture Hours.
Introduction to nanotechnology with an emphasis on biomedical techniques and medical applications; material covered ranges from the basic physics of contrast agents to the engineering of current sensing and imaging systems applied at the nanoscale.
Prerequisites: PHYS 208, MATH 308.

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 420; ECEN 410, or ECEN 411, or approval of instructor; graduate classification.
Cross Listing: ECEN 763/BMEN 627.

BMEN 628 Microcontrollers and Communications in Medical Devices
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 630 Global Medical Device Regulation
Credits 3. 3 Lecture Hours.
Overview of applicable U.S. and international regulations and regulatory processes for the design, approval and marketing of medical devices.
Prerequisite: 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: BMEN 240 and MATH 308.  

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.  
Prerequisite: 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.  
Understanding the relationship that clinical presentation has for patients with primary heart disease; inflammation and repair, systematic pathology emphasis on cardiovascular disease, and the implantable device intervention as a therapeutic adjunct in the heart.  
Prerequisite: Graduate classification or approval of instructor.  

BMEN 640 Design of Medical Devices  
Credits 3. 3 Lecture Hours.  
Overview of the multiple issues in managing the design of a marketable medical device, including the design process from clinical problem definition through prototype and clinical testing to market readiness; includes FDA pre- and post-market regulation, human factors and system safety considerations, and medical product liability.  
Prerequisite: 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 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 652 Cell Mechanobiology  
Credits 3. 3 Lecture Hours.  
Focuses on how mechanical forces influence cell behavior through physical and biochemical mechanisms; objectives include integrating engineering and cell biology to solve biomedical problems, which includes developing models for applying forces to cultured cells and tissues and measuring changes in cell biochemistry, structure, and function.  
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 660 Vascular Mechanics  
Credits 3. 3 Lecture Hours.  
Application of continuum mechanics to the study of the heart arteries; on the measurement and quantification of material properties, and the calculation of vascular stresses; analysis of several cardiovascular devices to reinforce the need for careful analysis in the device design.  
Prerequisites: BMEN 240 and BMEN 341 or equivalents.  

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 662 Vascular Fluid Mechanics  
Credits 3. 3 Lecture Hours.  
Bio-fluid mechanics of the human circulatory system including examination of disease development and medical treatments.  
Prerequisites: BMEN 240 or equivalent.  

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 associating applications in biomedicine.  
Prerequisite: Graduate classification or approval of instructor.
BMEN 669 Entrepreneurial Issues in Biomedical Engineering  
Credits 3. 3 Lecture Hours.  
Description and analysis of issues associated with initiating business ventures to transfer biomedical technologies into the health care sector, including intellectual engineering technology area; and utilizing recent case studies of previous ventures.  
Prerequisite: Approval of instructor.

BMEN 672/NUEN 672 Introduction to Diagnostic Radiology Physics  
Credits 3. 2 Lecture Hours. 3 Lab Hours.  
This course presents the concepts of radiation physics used in diagnostic radiology by providing an introduction to the theory behind the different imaging modalities as it relates to mammography, planar X-ray imaging, computed tomography (CT), single photon emission tomography (SPECT), and positron emission tomography (PET).  
Prerequisite(s): NUEN 611, NUEN 613 or approval from academic advisor.  
Cross Listing: NUEN 672.

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 3. 3 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: BMEN 343 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: BMEN 342, 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.  
Prerequisites: BMEN 343 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.  
Prerequisites: BMEN 343, 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.