

# BIOMEDICAL ENGINEERING (BMEN)

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## **BMEN 501 Circuits and Signal Processing in Biomedical Engineering (1 Unit)**

Prerequisite: Graduate standing in College of Engineering and Polymer Science or permission of instructor. Fundamentals of circuits and signal processing for biomedical engineers. Circuit analysis; biological signal and image processing applications and approaches.

## **BMEN 502 Materials in Biomedical Engineering (1 Unit)**

Prerequisite: Graduate standing in College of Engineering and Polymer Science or permission of instructor. Fundamentals of materials for biomedical engineers. Classification of materials; crystalline structure, bulk and surface properties. Metals, polymers, and ceramics.

## **BMEN 503 Mechanics in Biomedical Engineering (1 Unit)**

Prerequisite: Graduate standing in College of Engineering and Polymer Science or permission of instructor. Fundamentals of mechanics for biomedical engineers. Dimensional analysis and systems of units; force vectors. Statics, stress and strain.

## **BMEN 504 Transport in Biomedical Engineering (1 Unit)**

Prerequisite: Graduate standing in College of Engineering and Polymer Science or permission of instructor. Fundamentals of transport phenomena for biomedical engineers. Mass, momentum, and energy balance. Viscosity, shear stress, head loss. Differential equations of fluid flow; diffusivity. Mass transfer.

## **BMEN 522 Physiological Control Systems (3 Units)**

Prerequisite: BIOL 202 and MATH 335. The basic techniques employed in control theory, systems analysis, and model identification as they apply to physiological systems. (Formerly 4800:522)

## **BMEN 530 Design of Medical Imaging Systems (3 Units)**

Prerequisites: BIOL 200, PHYS 292, ELEN 340, BMEN 305, or by permission of instructor. Physical principles and engineering design of medical imaging systems, with emphasis on digital radiography, computed tomography, nuclear medicine, ultrasound and magnetic resonance. (Formerly 4800:530)

## **BMEN 560 Experimental Techniques in Biomechanics (3 Units)**

Prerequisites: CHEM 153, MATH 335, PHYS 292, MECE 203 or by permission. Principles of testing and measuring devices commonly used for biofluid and biosolid mechanics studies. Laboratories for demonstration and hands-on experience. (Formerly 4800:560)

## **BMEN 570 Human Factors Engineering (3 Units)**

Reliability and human error, human capabilities and limitations, crew protection, display systems, controls and controlling actions, interface design principles, risk management, Safety and accident prevention. (Formerly 4800:570)

## **BMEN 600 BME Graduate Colloquium (1 Unit)**

(May be repeated for a maximum of 16 credits.) The Biomedical Engineering Colloquium is a seminar series designed to introduce students to current topics in biomedical engineering research, design and business. (Formerly 4800:600)

## **BMEN 605 Fundamentals of Biomedical Engineering (4 Units)**

Prerequisites: Graduate Standing in College of Engineering or permission of instructor. This course covers the fundamental areas of biomedical engineering including biomechanics, biomaterials, signal/image processing, biotransport phenomena, controls, and emerging areas. (Formerly 4800:605)

## **BMEN 606 Physiology for Biomedical Science and Engineering (3 Units)**

An integrative study of the various human body functions with emphasis on cellular, neuromuscular, cardiovascular, and renal physiology and their applications in biomedical engineering. (Formerly 4800:606)

## **BMEN 611 Biometry (3 Units)**

Statistics and experimental design topics for the biomedical and biomedical engineering disciplines including: distributions, hypothesis testing and estimation, ANOVA, probit analysis and nonparametrics statistics. (Formerly 4800:611)

## **BMEN 620 Neural Networks (3 Units)**

Examination of highly parallel, distributed architectures for computing that are, to varying degrees, derived from structures observed in biological nervous systems. After an overview of how real neurons operate, the course will examine both classical and modern neural computing architectures. Comparisons will be made with traditional serial machines and applications for which neural networks seem most promising will be examined. (Formerly 4800:620)

## **BMEN 627 Advances in Drug and Gene Delivery Systems (3 Units)**

This course will examine technological innovations for the delivery of drugs and genes. Methods of introducing drugs and genes into the body, modeling drug transport, and metabolic responses of cells and organs will be analyzed. (Formerly 4800:627)

## **BMEN 630 Biomedical Computing (3 Units)**

Prerequisite: 4100:206 or equivalent. Computer applications in health care, clinical laboratories, AMHT, medical records, direct order entry, A-D, D-A conversion, patient monitoring, peripherals and interfaces, diagnostic algorithms, automated EEG, ECG systems. (Formerly 4800:630)

## **BMEN 631 Biomedical Instrumentation I (4 Units)**

Prerequisites: BMEN 605 or permission of the instructor. This course covers biomedical equipment, bio-signals and processing techniques, biomedical sensors/transducers, signal conditioning, data acquisition, noise control, device safety, and modern medical imaging systems. (Formerly 4800:631)

## **BMEN 633 Biomedical Optics (3 Units)**

Application of lightwave principles and optical fibers on the engineering design and development of instrumentation, techniques, and applications for medical diagnostic imaging, and treatment of disease. (Formerly 4800:633)

## **BMEN 634 Medical Imaging Devices (3 Units)**

Imaging modalities including radiation, magnetic resonance, and sound. The formation of images. Specific devices including computer tomography, magnetic resonance, ultrasound, gamma cameras and PET. (Formerly 4800:634)

## **BMEN 640 Spine Mechanics (3 Units)**

Physical properties and functional biomechanics of the spine. Kinematics and kinetics of the human spine. Biomechanics of scoliosis, trauma, instability, pain, and orthoses. Mechanics and design of surgical implants. (Formerly 4800:640)

## **BMEN 642 Hard Connective Tissue Biomechanics (3 Units)**

Prerequisite: CIVE 407 or equivalent; or permission. Physical properties and functional biomechanics of bone. The biology and mechanics of fracture and fracture healing. Mechanics of external and internal fixators. Total joint implants and reconstruction techniques. (Formerly 4800:642)

**BMEN 645 Mechanics in Physiology & Medicine (3 Units)**

Prerequisites: MECE 310 and CIVE 202 or equivalent. Blood rheology, mechanics of microcirculation, finite deformation theory, soft tissue mechanics, mechanics of blood and lymph circulation, kinetics and kinematics of orthopedic joints. Clinical applications. (Formerly 4800:645)

**BMEN 647 Kinematics of the Human Body (3 Units)**

Prerequisites: MECE 321 or equivalent, graduate standing in the College of Engineering or by permission. Analytical methods used to model and quantify human body motion. Three-dimensional kinematics, joint coordinate systems, functional anatomy, segment center of mass and joint centers. (Formerly 4800:647)

**BMEN 650 Cardiovascular Dynamics (3 Units)**

Analysis of blood pumping action, pressure/flow waveforms and transmission through circulation and blood rheology factors. Use of various modeling and measurement techniques. Clinical implications related to disease. (Formerly 4800:650)

**BMEN 653 Transport Phenomena in Biology & Medicine (3 Units)**

Prerequisites: CHEE 321 and 4200:322 or MECE 310 and MECE 315 or equivalent. Basic definitions, cardiovascular mass and momentum transport, compartment modeling, mass transfer in physiological systems and artificial kidney and lung devices, Design optimization. Analysis of human thermal system. (Formerly 4800:653)

**BMEN 654 Microfluidics in Biotechnology (3 Units)**

Prerequisite: BMEN 605 or permission of instructor. This course integrates principles of fluid mechanics, surface and polymer sciences, and microfabrication to analyze flow of biofluids at the microscale. (Formerly 4800:654)

**BMEN 655 Rehabilitation Engineering (3 Units)**

Prerequisites: graduate standing in engineering, mathematics, or science; or permission of the instructor. Devices for rehabilitation, interfacing the motor and/or sensory impaired, quantitative assessment techniques, prosthetics and orthotics, bedsores mechanics, emerging technologies. (Formerly 4800:655)

**BMEN 660 Biomaterials & Laboratory (4 Units)**

Corequisite: Biomaterials Laboratory. Material uses in biological applications. Effect of physiological environment and sterilization on materials. Controlled and uncontrolled degradation. Effect of materials on soft tissue, hard tissue and blood. Laboratory experiments using materials designed for biomedical use and demonstrations of biological/materials interactions. (Formerly 4800:660)

**BMEN 661 Advanced Biomaterials (3 Units)**

Prerequisite: BMEN 660 or permission of instructor. The objective of this course is to provide the fundamental understanding of the host responses when exposed to various implantable devices and biomaterials. Methods for testing biocompatibility will be analyzed. (Formerly 4800:661)

**BMEN 662 Tissue Engineering & Regenerative Medicine (3 Units)**

Prerequisites: BMEN 661 or permission. This course will cover topics including basic developmental biology, quantitative description of biological processes, and integration of cells with materials to regenerate tissue. (Formerly 4800:662)

**BMEN 663 Artificial Organs (3 Units)**

Prerequisite: graduate standing in the College of Engineering and Polymer Science or permission of instructor. Study of the rationale for the engineering and clinical aspects required for the design and variety of artificial organs, with emphasis on the artificial heart and artificial kidney. (Formerly 4800:663)

**BMEN 665 Biomaterials and Tissue Engineering Methods (3 Units)**

Prerequisite: BMEN 660; Corequisite: BMEN 661; or permission of the instructor. This course is design to equip students with knowledge and skills to evaluate biomaterials and to design scaffolds for tissue engineering. Analytical techniques include principles of microscopy, cell culture techniques, and biocompatibility testing. (Formerly 4800:665)

**BMEN 670 Mathematical Modeling in Biology & Medicine (3 Units)**

Prerequisites: graduate standing in engineering, mathematics, or physics; or permission of instructor. Modeling of pharmacokinetic, cardiovascular, neuromuscular, and immune systems, and artificial organ interactions. Deterministic and stochastic approaches. (Formerly 4800:670)

**BMEN 685 Medical Devices & Artificial Organs (3 Units)**

Prerequisites: graduate standing in engineering, mathematics, or science; or permission of instructor. Design of medical devices and artificial organs, requirements, safety considerations, tissue constraints, optimization techniques, government regulations, and legal liability. (Formerly 4800:685)

**BMEN 696 Engineering Report (2 Units)**

Prerequisites: Admission to Biomedical Engineering and permission of the advisor. A relevant problem in Biomedical Engineering for students electing the non-thesis option. The final engineering report must be approved by the advisor and the advisory committee. (Formerly 4800:696)

**BMEN 697 Special Topics: Biomedical Engineering (1-4 Units)**

(May be repeated.) Specialized areas of study as defined by the instructor. (Formerly 4800:697)

**BMEN 698 Masters Research (1-6 Units)**

Prerequisite: Permission of advisor. (May be repeated.) Research on a suitable topic in biomedical engineering culminating in a master's thesis. (Formerly 4800:698)

**BMEN 699 Masters Thesis in Biomedical Engineering (1-6 Units)**

Prerequisite: permission of advisor. (May be repeated) Supervised research in a specific area of biomedical engineering. (Formerly 4800:699)

**BMEN 898 Preliminary Research (1-15 Units)**

(May be repeated) Prerequisite: Approval of the dissertation director. Preliminary investigations prior to the submission of a dissertation proposal to the Interdisciplinary Doctoral Committee. (Formerly 4800:898)

**BMEN 899 Doctoral Dissertation (1-15 Units)**

Prerequisite: acceptance of research proposal by the Interdisciplinary Doctoral Committee and approval of the dissertation director. (May be repeated) Original research by the doctoral student. (Formerly 4800:899)