

# BIOMEDICAL ENGINEERING (BMED)

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## **BMED 6041. Analytical Methods for Biomedical Engineering. 3 Credit Hours.**

Basic analytical approaches to solve mathematical problems involved in biomedical engineering applications. Course focuses on ordinary and partial differential equations and on integral transform methods.

## **BMED 6042. Systems Physiology. 3 Credit Hours.**

Regulation of physiological functions in the cardio-respiratory-renal, musculoskeletal, and gastrointestinal systems, and their interactions with the neural, endocrine, and immune systems.

## **BMED 6210. Magnetic Resonance Imaging. 3 Credit Hours.**

This course covers the basic physics and engineering principles, advanced techniques and major applications of magnetic resonance imaging.

## **BMED 6501. Fundamentals of Biomedical Innovation and Development Processes. 3 Credit Hours.**

Key steps, multiple stakeholders and interdependencies in the design and commercialization process for medical products.

## **BMED 6502. BioID Clinical Literacy and Experience. 3 Credit Hours.**

Education in interfacing with medical healthcare professionals, medical terminology, on-site clinical observations, needs-finding, case analysis, creating design solutions for improved methods, products and procedures.

## **BMED 6503. Medical Markets and Clinical Specialties. 3 Credit Hours.**

Introduction to medical device and biologics industries, interdependencies of commercial companies, vendors and suppliers required for development, commercialization and sales of products and equipment.

## **BMED 6504. Financial Planning for Development Projects. 3 Credit Hours.**

Finance planning for development projects including: costing, forecasting, time value of money, breakeven analysis, return on investment analysis, capital budgeting, risk and return, working capital management.

## **BMED 6505. Product Planning and Project Management. 3 Credit Hours.**

Strategy and analysis techniques to evaluate and manage new product innovations, product improvements and product line extensions in context of an entity's mission and goals.

## **BMED 6506. Professional Communications for Biomedical Innovation and Development. 3 Credit Hours.**

Techniques and practice of effective oral presentations project/grant proposal writing, technical and project report writing to support medical device engineering, design and business.

## **BMED 6507. Medical Device Regulatory Requirements. 3 Credit Hours.**

FDA Regulations for medical devices including clearance-approval pathways to commercialization, Quality Systems Regulations and ISO Standards for medical devices in the European Economic Community.

## **BMED 6508. BioID Team Masters Project I. 3 Credit Hours.**

Team project to address an unmet medical need and develop an innovative solution including the engineering design document package and proof-of-concept prototype.

## **BMED 6509. BioID Masters Project II. 6 Credit Hours.**

Teams will construct prototypes for Course I biomedical device project solution, conduct and analyze performance testing, prepare FDA 510(k) submission, and prepare project commercialization plan.

## **BMED 6517. Machine Learning in Biosciences. 3 Credit Hours.**

Introduces machine learning concepts and methods, including supervised and unsupervised learning, dimension reduction and visualization. Topics are accompanied by bioinformatics and systems biology applications.

## **BMED 6700. Biostatistics. 3 Credit Hours.**

An introduction to fundamental ideas and techniques in Biostatistics, with an emphasis on conceptual understanding and on the analysis of real data sets.

## **BMED 6710. Rational Design of Biomaterials. 3 Credit Hours.**

The goal of this course is to give graduate students the ability to rationally design new biomaterials by integrating organic chemistry concepts with molecular biology.

## **BMED 6711. Rational Design of Biomaterials Lab. 3 Credit Hours.**

The goal of this course is to teach students the laboratory skills needed to design and synthesize new biomaterials.

## **BMED 6720. Biotransport. 3 Credit Hours.**

This graduate level course covers the analysis of fluid flow phenomena in the human body, cardiovascular, respiratory system and other organ systems.

## **BMED 6730. Materials Science of Cellular Components. 3 Credit Hours.**

Addresses structure-property relationship of cellular components. Credit not allowed for both BMED 6730 and MSE 6730.

## **BMED 6739. Medical Robotics. 3 Credit Hours.**

This interdisciplinary course focuses on a fundamental understanding of robot kinematics and dynamics as well as the design, development, and evaluation of a medical robotic system.

## **BMED 6740. Living System Modeling & Analysis. 3 Credit Hours.**

The purpose of this course is to introduce graduate students to living system models as pre-clinical test beds for a wide variety of biotechnologies.

## **BMED 6743. Biosolid Mechanics. 3 Credit Hours.**

Structure-function relationships and constitutive models for a variety of biological tissues, with an emphasis on understanding the mechanical behaviors of normal and pathological tissues. Credit not given for both BMED/ME 6783 and BMED/ME 6743. Crosslisted with ME 6743.

## **BMED 6753. Principles of Management for Engineers. 3 Credit Hours.**

The course will provide an introduction to selected topics needed to be successful in the technology industries. Cannot count toward major area requirements in M.S. or Ph.D. programs of study.

## **BMED 6760. Information Processing Models in Neural Systems. 3 Credit Hours.**

This course will examine "top down" modeling approaches for sensorineural systems, where an optimal computational principle used in engineering (e.g., information theory, Bayesian inference, control theory) explains observed information processing.

## **BMED 6765. Drug Design, Development and Delivery. 3 Credit Hours.**

Introduction to the pharmaceutical development process, including design of new drugs, synthesis and manufacturing issues, and methods of delivery into the body. Includes student presentations. Crosslisted with BMED 6765 and CHBE 6765.

**BMED 6774. Biomaterials: Structure and Function. 3 Credit Hours.**

Structure-function relationships of biomaterials and biomaterial characterization will be covered. Materials for medial implants, tissue engineering, biosensing, imaging, and drug delivery will be covered. Crosslisted with CHE, ME, and MSE 6774.

**BMED 6777. Advanced Biomaterials. 3 Credit Hours.**

Advanced topics of biomaterials performance and engineering, including biointerfaces, host reactions to materials, and bio-inspired/smart-materials strategies. Crosslisted with CHE, ME, and MSE 6777.

**BMED 6779. Bioprocess Engineering. 3 Credit Hours.**

Study of enzymes and microbial and mammalian cells for production of biochemicals and protein therapeutics in bioreactors; downstream separation and purification; integrated view of bioprocesses. Crosslisted with CHE 6779.

**BMED 6780. Medical Image Processing. 3 Credit Hours.**

A study of methods for enhancing, analyzing, interpreting, and visualizing information from two- and three-dimensional data obtained from a variety of medical imaging modalities. Crosslisted with ECE and CS 6780.

**BMED 6782. Cellular Engineering. 3 Credit Hours.**

Engineering analysis of cellular systems. Crosslisted with CHE and ME 6782.

**BMED 6784. Cardiovascular Biomechanics. 3 Credit Hours.**

Mechanical analysis of the cardiovascular system emphasizing the normal and pathologic function in relation to clinical cardiovascular medicine. Crosslisted with CHE and ME 6784.

**BMED 6786. Medical Imaging Systems. 3 Credit Hours.**

A study of the principles and design of medical imaging systems such as X-ray, ultrasound, nuclear medicine, and nuclear magnetic resonance. Crosslisted with ECE 6786.

**BMED 6787. Quantitative Electrophysiology. 3 Credit Hours.**

A quantitative presentation of electrophysiological systems in biological organisms, emphasizing the electrical properties and modeling of neural and cardiac cells and systems. Crosslisted with PHYS and ECE 6787.

**BMED 6789. Technology Ventures. 3 Credit Hours.**

Team discussion and case studies in biomedical engineering technology transfer, including licensing, financial capital, safety and efficacy studies, clinical trials, and strategic planning. Crosslisted with ECE, CHE, ME, and MGT 6789.

**BMED 6790. Information Processing Models in Neural Systems. 3 Credit Hours.**

Examines "top-down" modeling approaches for sensorineural systems, where optimal computational principles used in engineering (e.g., information theory, Bayesian inference, control theory) explain observed information processing.

**BMED 6793. Systems Pathophysiology. 3 Credit Hours.**

Overview of human pathophysiology from a quantitative perspective. A brief introduction to the application of quantitative models to the understanding of biological systems. Crosslisted with CHE, ECE, and ME 6793.

**BMED 6794. Tissue Engineering. 3 Credit Hours.**

Biological, engineering, and medical issues in developing tissue engineered constructs. Emphasis in the integration of these disciplines at a basic molecular and cell biology level. Crosslisted with CHE and ME 6794.

**BMED 6799. Legal Issues in Technology Transfer. 3 Credit Hours.**

Study and analysis of U.S. law as it applies to the patenting and licensing processes. Crosslisted with CHE, ME, and MGT 6799.

**BMED 6XXX. Bioengineering Elective. 1-21 Credit Hours.****BMED 7000. Master's Thesis. 1-21 Credit Hours.****BMED 7001. Biomedical Engineering Seminar. 1 Credit Hour.**

Graduate students of the Biomedical Engineering department (all programs) participate in seminars involving current research projects presented by faculty and invited speakers.

**BMED 7002. Teaching Practicum I. 1 Credit Hour.**

This course provides discipline-specific training that addresses intellectual problems and teaching strategies from the perspective of the discipline. Credit not allowed for both BMED 7002 and BMED 8696.

**BMED 7003. Teaching Practicum II. 1 Credit Hour.**

This course provides discipline-specific training that addresses intellectual problems and teaching strategies from the perspective of the discipline. Credit not allowed for both BMED 7003 and BMED 8697.

**BMED 7004. Teaching & Research Practicum I. 1 Credit Hour.**

This course provides the practical framework for understanding challenges faced during teaching, research, and academic life. This course includes topical materials required for BME RCR requirements.

**BMED 7005. Teaching & Research Practicum II. 1 Credit Hour.**

This course provides the practical framework for understanding challenges faced during teaching, research, and academic life.

**BMED 7011. Integrative Core: Introduction to Modeling and Experimentation in Biomedical Engineering. 3 Credit Hours.**

An introduction to how engineers approach problems - via conceptual models that are then used to create wet lab models and in silico models.

**BMED 7012. Integrative Core: Experimental Design-Measurements at the Right Spatial and Temporal Scales. 3 Credit Hours.**

This integrative core course focuses on the design of experiments to answer scientific questions, with an emphasis on the spatial and temporal scales of measurements.

**BMED 7013. Integrative Core: Problem Solving with Computational Models. 3 Credit Hours.**

An introduction to computational model methodologies for complex biomedical/biological systems. Emphasis is placed on developing well-posed scientific hypotheses through the use of simulations.

**BMED 7101. Advanced Seminar: Biomaterials & Regenerative Medicine. 3 Credit Hours.**

This course is intended to promote critical review of the "State-of-the-art" biomaterial technologies to identify knowledge gaps that must be overcome to further biomaterials development.

**BMED 7201. Advanced Seminar: Cardiovascular Biology & Biomechanics. 3 Credit Hours.**

To review current topics in cardiovascular engineering, biology and diseases through critical literature review. In addition, each student will develop and present a "Proposal" by the end of the class.

**BMED 7301. Advanced Seminar: Cellular & Biomolecular Engineering. 3 Credit Hours.**

This seminar course illustrates the development of micro- and nano-scale engineering approaches for studies of biomolecules and cells and their applications to medicine.

**BMED 7310. Stem Cell Engineering. 3 Credit Hours.**

Fundamentals for the application of analytical engineering approaches to the quantitative study of stem cell biology and translation into cell therapies and diagnostics.

**BMED 7410. Introduction to Multiscale Analysis in Systems. 3 Credit Hours.**

The class explores modeling analyses spanning multiple levels of biological organization at different resolutions of detail. Emphasis is placed on control in complex biological systems.

**BMED 7411. Mathematical Models in Biology & Medicine. 3 Credit Hours.**

The course introduces the student to a representative set of models that elucidate the nature of biological and medical phenomena.

**BMED 7413. Biochemical Systems Analysis. 3 Credit Hours.**

The course introduces BME students interested in mathematical modeling and systems biology to the computational analysis of metabolic and other dynamic systems in biology.

**BMED 7601. Advanced Seminar: Neuroengineering and Neuropathology. 3 Credit Hours.**

Current issues in neuroengineering. Focus is placed on neuropathological complexity across cellular and organ level scales through literature reading, discussion, and independent study.

**BMED 7610. Quantitative Neuroscience. 3 Credit Hours.**

A quantitative presentation of neural signal processing and information coding, emphasizing the circuitry of sensory and motor pathways of the brain.

**BMED 7741. Robotics Professional Preparation. 1 Credit Hour.**

Preparation for a professional career in Robotics. Local & visiting speakers. Program introduction. Technical resume preparation. GT Robotics labs & resources.

**BMED 7742. Robotics Professional Preparation 2. 1 Credit Hour.**

Preparation for a professional career in Robotics. Local & visiting speakers. Selecting and applying for Internship. Developing capstone project proposal. Public speaking practice and preparation.

**BMED 7743. Robotics Professional Preparation 3. 1 Credit Hour.**

Preparation for a professional career in Robotics. Local & visiting speakers. Interview preparation & career search. Technical report writing and presentation.

**BMED 7785. Introduction to Robotics Research. 3 Credit Hours.**

Familiarizes students with the core of robotics: mechanics, control, perception, AI, and autonomy. Provides an introduction to the mathematical tools required in robotics research. Cross-listed with AE 7785, ECE 7785, and CS 7785.

**BMED 8740. Robotics Internship. 1-21 Credit Hours.**

Graduate Internship at a partner company, GTRI or a GT Robotics lab.

**BMED 8741. Robotics Capstone Project. 3 Credit Hours.**

Teams or individuals apply the knowledge and skills acquired throughout the MS program to a faculty supervised robotics project.

**BMED 8750. Multidisciplinary Robotics Research I. 3 Credit Hours.**

Multidisciplinary research course supervised by two robotics faculty from different schools participating in the robotics Ph.D. program. Cross-listed with AE, CS, and ECE 8750.

**BMED 8751. Multidisciplinary Robotics Research II. 3 Credit Hours.**

Continuation of BMED 8750 (Multidisciplinary Robotics Research I). Cross-listed with AE, CS, and ECE 8751.

**BMED 8811. Special Topics. 1 Credit Hour.**

Topics of current interest in biomedical engineering.

**BMED 8812. Special Topics. 2 Credit Hours.**

Topics of current interest in biomedical engineering.

**BMED 8813. Special Topics. 3 Credit Hours.**

Topics of current interest in biomedical engineering.

**BMED 8814. Special Topics. 4 Credit Hours.**

Topics of current interest in biomedical engineering.

**BMED 8815. Special Topics. 5 Credit Hours.**

Topics of current interest in biomedical engineering.

**BMED 8823. Special Topics. 3 Credit Hours.**

Topics of current interest in biomedical engineering.

**BMED 8833. Special Topics. 3 Credit Hours.**

Special Topics.

**BMED 8843. Special Topics. 3 Credit Hours.**

Special Topics.

**BMED 8853. Special Topics. 3 Credit Hours.**

Topics of current interest in biomedical engineering.

**BMED 8901. Special Problems. 1-21 Credit Hours.**

Individual studies and/or experimental investigations of problems of current interest in bioengineering.

**BMED 8902. Special Problems. 1-21 Credit Hours.****BMED 8903. Special Problems. 1-21 Credit Hours.****BMED 8997. Teaching Assistantship. 1-9 Credit Hours.**

For graduate students holding a teaching assistantship.

**BMED 8998. Research Assistantship. 1-9 Credit Hours.**

For graduate students holding a research assistantship.

**BMED 9000. Doctoral Thesis. 1-21 Credit Hours.**