

BIOMEDICAL ENGINEERING

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Chairperson: Cynthia Bir

Associate Chairperson: Harini Sundararaghavan (COE)

<http://engineering.wayne.edu/bme/>

The field of biomedical engineering applies engineering science and design to the solution of problems related to human physiology and pathophysiology. Working at the interface of engineering and medicine, biomedical engineers work to prevent injury, diagnose disease, and treat illnesses or injuries that occur. Built on a strong research foundation that stretches back more than eighty years, the biomedical engineering program at Wayne State provides coursework and research opportunities in a broad range of areas in biomechanics, tissue engineering and biomaterials, biomedical imaging, bioinstrumentation, and computational biology.

BIR, CYNTHIA: Ph.D., M.S., Wayne State University; M.S., University of Michigan; B.S.N., Nazareth College; Professor and Chair

CAVANAUGH, JOHN: M.D., B.S., Michigan State University; M.S., Wayne State University; Professor

KAVDIA, MAHENDRA: Ph.D., Oklahoma State University; MTech, Indian Institute of Technology; BTech, Indian Institute of Technology; Associate Professor

KLUEH, ULRIKE: Ph.D., M.S., University of Connecticut; B.A.Sc., University of Applied Sciences Mittelhessen; Associate Professor

KOU, ZHIFENG: Ph.D., M.S., North Dakota State; M.S., Shanghai Tiedao University; B.S., Shanghai Institute of Railway Technology; Associate Professor

LAM, MAI T.: Ph.D., M.S.E., B.S.E., University of Michigan; Assistant Professor

MEHRMOHAMMADI, MOHAMMAD: Ph.D., University of Texas at Austin; M.Sc., Illinois Institute of Technology; B.Sc., Sharif University of Technology; Assistant Professor

MUNDO, BRIAN: M.S., Wayne State University; B.E., University of Michigan; Lecturer

SUNDARARAGHAVAN, HARINI: Ph.D., Rutgers, State University of New Jersey; B.S.E., University of Michigan; Associate Professor

WASHABAUGH, EDWARD PETER: Ph.D., B.S.E., University of Michigan; Assistant Professor

YANG, KING-HAY: Ph.D., M.S., Wayne State University; B.S., National Taiwan University; Professor

ZHANG, JIATO: Ph.D., Tsinghua University; B.S., Wuhan University; Assistant Professor

ZHANG, LIYING: Ph.D. Wayne State University; M.S. and B.S. Shanghai Jiao Tong University; Associate Professor

- Biomedical Engineering (M.S.) (<http://bulletins.wayne.edu/graduate/college-engineering/biomedical-engineering/biomedical-engineering-ms/>)
- Biomedical Engineering (Ph.D.) (<http://bulletins.wayne.edu/graduate/college-engineering/biomedical-engineering/biomedical-engineering-phd/>)

- Biomedical Imaging (dual-title program) (<http://bulletins.wayne.edu/graduate/college-engineering/biomedical-engineering/biomedical-imaging-dual-title-program/>)
- Injury Biomechanics (Bridge Graduate Certificate) (<http://bulletins.wayne.edu/graduate/college-engineering/biomedical-engineering/injury-biomechanics-bridge-graduate-certificate/>)

BME 5010 Quantitative Physiology Cr. 4

Basic principles of human physiology presented from the engineering perspective. Bodily functions, their regulation and control discussed in quantitative terms and illustrated by mathematical models where feasible. Offered Fall, Winter.

Equivalent: CHE 5100, ECE 5100, ME 5100

BME 5020 Computer and Mathematical Applications in Biomedical Engineering Cr. 4

Application of numerical methods in biomedical engineering. Programming algorithms and development of data analysis interfaces using Matlab and Excel. Development and refinement of mathematical models, binary data storage and round-off error, algorithm truncation error, and application of Taylor series for function approximation, error estimation, and algorithm development. Numerical methods for solving: roots of equations, systems of linear equations, system optimization, regression and interpolation, integration, differentiation, and ordinary and partial differential equations. Attention is focused on application of techniques within biomedical engineering. Offered Fall, Winter.

BME 5070 Anatomy for Engineers Cr. 4

A cadaver based anatomy course for undergraduate students and MS-level students in biomedical engineering. This hands-on course is intended to give the students directed experience of the study of human anatomy in relation to engineering principles. The histological study of tissues in relation to mechanical function of the organism is included in this study. Offered Fall.

Prerequisites: BME 2050 with a minimum grade of C-

Restriction(s): Enrollment is limited to Graduate or Undergraduate level students.

Course Material Fees: \$225

BME 5130 Vehicle Safety Engineering Cr. 4

Role of vehicle in road safety, occupation and pedestrian injury mechanisms, measures of vehicle safety performance, driver behavior and vehicle interface. Use of new technology to improve vehicle safety. Offered Every Other Year.

BME 5210 Musculoskeletal Biomechanics Cr. 4

Structure and properties of the major tissue components of the musculoskeletal system and evaluation of how tissues combine to provide support and motion to the body. Offered Fall.

Prerequisite: BME 5010 with a minimum grade of B-

Equivalent: ME 5160

BME 5220 Cellular and Tissue Biomechanics Cr. 3

Introduces biomechanics on the cellular to the tissue level. We will be studying mediators of cell mechanics such as the cytoskeleton, extracellular matrix and receptor-ligand interactions. Topics include cell adhesion, cell motility, and hemodynamics. Understanding of these topics will lead to discussion of translation of these forces up to the tissue level and subsequent tissue function. Offered Fall.

Prerequisites: MAT 2010 with a minimum grade of C- and MAT 2020 with a minimum grade of C-

BME 5310 Device and Drug Approval and the FDA Cr. 3

Government regulations and industrial procedures that lead to device/drug approval. Offered Spring/Summer.

BME 5320 Fundamentals in Implant Technology: Principles and Limitations Cr. 3

This course will describe the limitations of medical devices based on issues arising from body's immune defense system in regards to chemical biocompatibility and device biomechanics. Thus, the first portion will discuss the immune system with respect to both acute and chronic inflammation, the foreign body reaction, biomechanical factors such as motion and pressure to give rise to interfacial stressors and the processes involved in the tissue responses. The second portion will discuss examples and applications of implantable medical devices. We will also discuss biofilm formation, drug delivery applications and biomedical ethics topics relevant to the biomedical engineers and scientist. Finally, the course will address issues of intellectual property and patent acquisition. Offered Fall.

BME 5350 Regenerative Biology and Medicine for Biomedical Engineers Cr. 4

Introduces students specializing in biomedical engineering and premedical students to the conceptual and methodological principles of modern regenerative biology and medicine. Includes a review of research methods and achievements in this field and the translational applications of regenerative biology to tissue engineering and the development of regenerative therapies. Offered Intermittently.

BME 5370 Introduction to Biomaterials Cr. 4

Introduction to study of both biological materials (bone, muscle, etc.) and materials for medical applications. Topics include tissue properties and effects of pathology, biocompatibility, and design considerations. Offered Winter.

Prerequisites: BME 5010 with a minimum grade of C- (may be taken concurrently)

Equivalent: ME 5180

BME 5380 Biocompatibility Cr. 4

Introduces concepts and applications of biocompatibility. Cellular response to implants (e.g. prosthetics, gene therapies, cells, etc.) will be covered in detail, including wound healing, immune response, and foreign body response. Topics include stem cell effects; in vitro and in vivo studies; and synthetic and natural material body response. The course material will be applicable to implant design, gene therapies, and stem cell treatments. Offered Winter.

Prerequisites: BIO 1050 with a minimum grade of C-, BIO 1500 with a minimum grade of C-, or BIO 1510 with a minimum grade of C-

Equivalent: MSE 5385

BME 5425 Robotic Systems I Cr. 4

Introduction to robot kinematics and control. Computational algorithms for robot movement, sensor fusion, and intelligent behavior, which are needed to build a system that performs actions and interacts with its environment. Offered Fall.

Prerequisites: BE 2550 with a minimum grade of C-, BE 1500 with a minimum grade of C-, BME 5020 with a minimum grade of C-, or ECE 3040 with a minimum grade of C-

Equivalent: ECE 5425

BME 5990 Directed Study Cr. 1-4

Independent projects on subjects in the field of biomedical engineering. Offered Every Term.

Repeatable for 4 Credits

BME 5995 Special Topics in Biomedical Engineering I Cr. 1-4

Topics as announced in Schedule of Classes. Offered Intermittently.

Repeatable for 12 Credits

BME 6130 Accident Reconstruction Cr. 3

Passenger car and light truck behavior in collisions; recognition of roadway markings and vehicle damage used to analyze vehicle accidents and to use that evidence to reconstruct driver, vehicle and occupant dynamics at the time of the collision. Offered Spring/Summer.

BME 6470 Smart Sensor Technology I: Design Cr. 4

Introduction to various types of sensors and the design of basic analog VLSI circuit building blocks. Offered Winter.

Equivalent: ECE 6570, PHY 6570

BME 6480 Biomedical Instrumentation Cr. 4

Engineering principles of physiological measurements, signal conditioning equipment, amplifiers, recorders and transducers. Recent advances in instrumentation. Offered Winter.

Prerequisites: BME 5020 with a minimum grade of B- and ECE 3300 with a minimum grade of C-

Equivalent: ECE 6180, ME 6180

BME 6991 Internship in Industry Cr. 1-4

Industrial internship in biomedical engineering. Offered Every Term.

Repeatable for 4 Credits

BME 7010 Functional Anatomy Cr. 4

Gross dissection-based course designed to introduce students to the anatomical structures associated with major physiological functions important to biomedical engineering. Offered Spring/Summer.

Prerequisite: BME 5010 with a minimum grade of B-

Restriction(s): Enrollment is limited to students with a major in Biomedical Engineering; enrollment limited to students in a Doctor of Philosophy degree.

Course Material Fees: \$100

BME 7020 Cardiovascular Systems Modeling Cr. 4

Application of engineering principals and mathematical and computational techniques to cardiovascular systems. Partial differential equations, signal transduction pathway and biotransport modeling, and introduction to systems biology approaches. Offered Winter.

Restriction(s): Enrollment is limited to Graduate level students.

BME 7100 Mathematical Modeling in Impact Biomechanics Cr. 4

Review of models created for impact simulations. Regional impact simulation models. Human and dummy models subject to various restraint systems. Offered Intermittently.

Prerequisite: BME 5010 with a minimum grade of B-

Restriction(s): Enrollment is limited to Graduate level students.

Equivalent: ECE 7100, IE 7100, ME 7100

BME 7120 Applied Finite Element Methods in Biomechanical Analysis Cr. 4

Structural, stress, and strain analysis of the human body and/or artificial implants, using realistic biomechanical data for relevant tissues and material. Theoretical background and applied analysis. Offered Intermittently.

Prerequisite: BME 5010 with a minimum grade of C or BME 5070 with a minimum grade of C

Restriction(s): Enrollment is limited to Graduate level students.

BME 7150 Biomechanics of Blast-Related Injuries Cr. 3

This course covers new and old information developed by military researchers on injuries sustained by military personnel due to explosions or blasts caused by a variety of weapon systems. Injuries to body regions from head to foot are discussed. Particular emphasis is placed on injuries to the spine and lower extremities for the mounted soldier and on brain injury for both the mounted and dismounted soldier. The course includes the modeling of blast and blast-related effects on selected body regions. Offered Fall.

Prerequisite: BME 7100 with a minimum grade of B- or BME 7160 with a minimum grade of B-

Restriction(s): Enrollment is limited to Graduate level students.

BME 7160 Impact Biomechanics Cr. 4

Biomechanical response of the body regions and the whole body to impact. Mechanisms of injury in blunt impact. Effects of restraints on injury reduction. Development of test surrogates such as dummies. Offered Fall.

Prerequisite: BME 5010 with a minimum grade of B-

Restriction(s): Enrollment is limited to Graduate level students.

Course Material Fees: \$10

Equivalent: ME 7160

BME 7170 Experimental Methods in Impact Biomechanics Cr. 4

Lecture and laboratory combined; principles of impact testing; hands-on experience in use of impact-test equipment, including sled, pendulum, other types of impactors, and drop-test techniques. Offered Every Other Winter.

Prerequisite: BME 6480 with a minimum grade of B- and (BME 7100 with a minimum grade of B- or BME 7160 with a minimum grade of B-)

Restriction(s): Enrollment is limited to Graduate level students.

Course Material Fees: \$100

BME 7180 Advanced Topics: Impact Biomechanics Cr. 4

A seminar format course in which advanced topics in impact biomechanics are investigated and presented by the class. Topics will include sports biomechanics (protective gear evaluation, standards certification, etc.) ballistic impacts (behind body armor effects, kinetic energy munitions, standards) and other various topics. The focus of the class will be the critical evaluation and review of literature. Offered Every Other Winter.

Prerequisite: BME 7160 with a minimum grade of B-

Restriction(s): Enrollment is limited to Graduate level students.

BME 7300 Advanced Topics in Biomaterials and Tissue Biomechanics Cr. 4

Seminar format: advanced topics presented to the class; lectures by the instructor and by the participants based on literature reviews. Topics determined by student interest. Offered Every Other Fall.

Prerequisite: BME 5210 with a minimum grade of C or BME 5370 with a minimum grade of C

Restriction(s): Enrollment is limited to Graduate level students.

Equivalent: ME 7180, MSE 7180

BME 7370 Biomaterial Interfaces Cr. 3

Effects of topography and texture on the performance of biomaterials. Self-organization of biomembranes and supramolecular systems. Offered Intermittently.

Prerequisite: BME 5370 with a minimum grade of B-

Restriction(s): Enrollment is limited to Graduate level students.

BME 7390 Tissue Engineering and Hybrid Systems Cr. 4

Seminar and project based approach to the design, development, analysis and application of organ and tissue replacement systems which incorporate processed materials and living cells. Offered Fall.

Prerequisites: BME 5370 with a minimum grade of C and (CHE 7100 with a minimum grade of C or BME 5020 with a minimum grade of C)

Restriction(s): Enrollment is limited to Graduate level students.

Equivalent: CHE 7390

BME 7425 Robotics Systems II Cr. 4

Project-based class to understand technology that interfaces computer engineering, software design, electronics and sensors with robotics. Advanced application areas of robotics will be covered including medical, military, space, vehicle robotics. Offered Winter.

Prerequisite: BME 5425 with a minimum grade of C or ECE 5425 with a minimum grade of C

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

Equivalent: ECE 7425

BME 7470 Smart Sensor Technology II: Characterization and Fabrication Cr. 4

Integration of ongoing research in integrated technology of smart sensors. Design of smart sensor devices using computer simulation. Fabrication of smart sensor. Offered Spring/Summer.

Prerequisite: BME 6470 with a minimum grade of B- or ECE 6570 with a minimum grade of B- or PHY 6570 with a minimum grade of B-

Restriction(s): Enrollment is limited to Graduate level students.

Course Material Fees: \$50

Equivalent: ECE 7570, PHY 7580

BME 7490 Biomedical Microsystems Cr. 4

Biomedical microsystems, with a focus on microfluidics and lab-on-a-chip technologies for medical diagnostics and biological research. Broad coverage of microscale physics; microfabrication methods; separation, purification, and other on-chip processes; biosensing. Offered Fall.

Prerequisite: ECE 5575 with a minimum grade of B- or ECE 6570 with a minimum grade of B- or BME 6470 with a minimum grade of B-

Restriction(s): Enrollment is limited to Graduate level students.

Equivalent: CHE 7490, ECE 7590

BME 7670 Experimental Methods in Physiology Cr. 3

Basic principles and techniques for monitoring and reading EMGs, EEGs, ECGs, respiratory cycle, pulmonary function, galvanic skin response and polygraph, human acceleration response. Designing and carrying out a project involving human body acceleration measures and EMG responses; a second project will be designed and carried out using measurement techniques chosen by the students. Offered Winter.

Prerequisite: BME 5010 with a minimum grade of B-

Restriction(s): Enrollment is limited to Graduate level students.

Course Material Fees: \$40

BME 7710 Magnetic Resonance Imaging Cr. 4

Science and engineering of magnetic resonance imaging; relaxation times, signal concepts, Fourier imaging, sampling, filtering, and sequence design. Offered Every Other Fall.

Prerequisite: BME 5020 with a minimum grade of B-

Restriction(s): Enrollment is limited to Graduate level students.

BME 7720 MR Imaging of Neurovascular Disease Cr. 3

Recent advances in MRI technology applied to human brain vascular diseases. Methods include: 3D anatomical imaging, diffusion tensor imaging, functional brain imaging, perfusion imaging, and susceptibility weighted imaging. Offered Every Other Fall.

Prerequisite: BME 5010 with a minimum grade of B-

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

Equivalent: PYC 7320

BME 7730 Medical Imaging Systems Cr. 3

Exposes students to the world of medical and biomedical imaging with emphasis on principles, approaches and applications of each modern imaging modality. Basic knowledge of MATLAB programming language is required. Offered Fall.

Restriction(s): Enrollment is limited to Graduate level students.

Equivalent: ECE 7740

BME 7990 Directed Study Cr. 1-4

Independent projects on subjects of interest in the field of biomedical engineering. Offered Every Term.

Restriction(s): Enrollment is limited to Graduate level students.

Repeatable for 12 Credits

BME 8070 Seminar in Biomedical Engineering Cr. 1

Lectures on biomedical engineering and related fields by guest speakers, faculty, and students. M. S. and Ph.D. students are required to take one semester. Offered Fall, Winter.

Restriction(s): Enrollment is limited to Graduate level students.

BME 8080 BME PhD Qualifying Exam Cr. 1

Qualifying exam and procedures to write the exam. Offered Winter.

Restriction(s): Enrollment is limited to students with a major in Biomedical Engineering; enrollment limited to students in a Doctor of Philosophy degree.

BME 8999 Master's Thesis Research and Direction Cr. 1-8

Offered Every Term.

Restriction(s): Enrollment is limited to students with a major in Biomedical Engineering; enrollment is limited to Graduate level students.

Repeatable for 8 Credits

BME 9990 Pre-Doctoral Candidacy Research Cr. 1-8

Research in preparation for doctoral dissertation. Offered Every Term.

Restriction(s): Enrollment is limited to students with a major in Biomedical Engineering; enrollment is limited to Graduate level students.

Repeatable for 8 Credits

BME 9991 Doctoral Candidate Status I: Dissertation Research and Direction Cr. 7.5

Offered Every Term.

Restriction(s): Enrollment is limited to students with a major in Biomedical Engineering; enrollment is limited to Graduate level students.

BME 9992 Doctoral Candidate Status II: Dissertation Research and Direction Cr. 7.5

Offered Every Term.

Prerequisite: BME 9991 with a minimum grade of S

Restriction(s): Enrollment is limited to students with a major in Biomedical Engineering; enrollment is limited to Graduate level students.

BME 9993 Doctoral Candidate Status III: Dissertation Research and Direction Cr. 7.5

Offered Every Term.

Prerequisite: BME 9992 with a minimum grade of S

Restriction(s): Enrollment is limited to students with a major in Biomedical Engineering; enrollment is limited to Graduate level students.

BME 9994 Doctoral Candidate Status IV: Dissertation Research and Direction Cr. 7.5

Offered Every Term.

Prerequisite: BME 9993 with a minimum grade of S

Restriction(s): Enrollment is limited to students with a major in Biomedical Engineering; enrollment is limited to Graduate level students.

BME 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction Cr. 0

Offered Every Term.

Restriction(s): Enrollment is limited to students with a major in Biomedical Engineering; enrollment is limited to Graduate level students.

Course Material Fees: \$402.01

Repeatable for 0 Credits