

BIOMEDICAL ENGINEERING (B M E)

B M E 1 – COOPERATIVE EDUCATION PROGRAM

1 credit.

Work experience which combines classroom theory with practical knowledge of operations providing a background upon which to base a professional career in industry. Enroll Info: None

Requisites: Sophomore standing

Course Designation: Workplace - Workplace Experience Course

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2022

B M E 200 – BIOMEDICAL ENGINEERING DESIGN

1 credit.

Sophomores will work in a team with juniors on a client-centered biomedical engineering design project to learn concept generation, product analysis, specifications, evaluation, clinical trials, regulation, liability, and ethics. Enroll Info: None

Requisites: Sophomore standing and declared in Biomedical Engineering

Repeatable for Credit: No

Last Taught: Fall 2021

B M E 201 – BIOMEDICAL ENGINEERING FUNDAMENTALS AND DESIGN

2 credits.

Fundamentals of biomedical engineering and principles of design. Hands-on skills including computer-aided design, machining, and fabrication of a physical medical device prototype. Enroll Info: None

Requisites: B M E 200

Repeatable for Credit: No

Last Taught: Spring 2022

B M E 300 – BIOMEDICAL ENGINEERING DESIGN

1 credit.

Juniors will work in a team with and provide mentorship to sophomores on a client-centered biomedical engineering design project to learn concept generation, product analysis, specifications, evaluation, clinical trials, regulation, liability, and ethics. Enroll Info: None

Requisites: B M E 201

Repeatable for Credit: No

Last Taught: Fall 2021

B M E 301 – BIOMEDICAL ENGINEERING DESIGN

1 credit.

Juniors will work in a team composed of all juniors on a client-centered biomedical engineering design project to learn concept generation, product analysis, specifications, evaluation, intellectual property, clinical trials, regulation, liability, and ethics. Enroll Info: None

Requisites: B M E 201

Repeatable for Credit: No

Last Taught: Spring 2022

B M E 310 – BIOINSTRUMENTATION

3 credits.

Bioinstrumentation covering clinical and research measurements. Laboratory experiments complement the lectures. Enroll Info: None
Requisites: (CHEM 104, 109, or 116), (MATH 222 or 276) and (PHYSICS 202, 208, or 248), or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Spring 2022

B M E 315 – BIOMECHANICS

3 credits.

An introduction to the mechanical behavior of biological tissues and systems. Specific topics include: structure and function of biological tissues, mechanical properties of biological tissues, and analysis of specific tissues (i.e. bone, muscle, and soft connective tissues). Enroll Info: None

Requisites: (E M A 303 or M E 306), or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Fall 2021

B M E 325 – APPLIED STATISTICS FOR BIOMEDICAL ENGINEERS

3 credits.

Learn and apply the fundamentals of descriptive and inferential statistics to analyze data and present the results in appropriate graphical formats. Emphasis will be on applications commonly encountered in biomedical engineering including t-tests, linear regression, analysis of variance, diagnostic tests, ROC curves, and methods for graphing and presenting data. Examples and practice problems will be drawn from biomedical research. Learn how to analyze data and interpret statistical analysis presented in research papers, and will get practical hands-on experience implementing these tools during class in a computer lab setting. Enroll Info: None

Requisites: Declared in Biomedical Engineering and (MATH 222 or 276)

Repeatable for Credit: No

Last Taught: Spring 2022

B M E 330 – ENGINEERING PRINCIPLES OF MOLECULES, CELLS, AND TISSUES

4 credits.

Introduction to the fundamental principles of kinetics and transport that are relevant for the analysis of biological systems. Topics covered include concepts of reaction rate, stoichiometry, equilibrium, momentum/mass transport, and the interaction between transport and kinetics in biological systems. Enroll Info: None

Requisites: (E M A 201, PHYSICS 201, 207, or 247), (MATH 319, 320, or 375) and (CHEM 104, 109, or 116), or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Fall 2021

B M E 389 – HONORS IN RESEARCH

1-3 credits.

Undergraduate honors research projects supervised by faculty members.

Enroll Info: None

Requisites: Consent of instructor

Course Designation: Honors - Honors Only Courses (H)

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2022

B M E 399 – INDEPENDENT STUDY

1-3 credits.

Directed study projects as arranged with instructor. Enroll Info: None

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2022

B M E 400 – CAPSTONE DESIGN COURSE IN BIOMEDICAL ENGINEERING

3 credits.

Applies classroom study and prior design course experiences for senior teams to solve a directed client-based biomedical engineering design project. Enroll Info: None

Requisites: (B M E 300 or B M E 301) and (B M E 310, 315, or PHM SCI/ B M E 430)

Repeatable for Credit: No

Last Taught: Fall 2021

B M E 402 – BIOMEDICAL ENGINEERING DESIGN

1 credit.

Final semester seniors will work in a team to evaluate, refine, document and orally present the client-centered biomedical engineering design completed in their prior capstone design course. Enroll Info: None

Requisites: B M E 400

Repeatable for Credit: No

Last Taught: Spring 2022

B M E/M E 414 – ORTHOPAEDIC BIOMECHANICS - DESIGN OF ORTHOPAEDIC IMPLANTS

3 credits.

Apply the design process for orthopaedic implants (total joint replacements). Topics include: library skills; joint anatomy; tissue properties; surgical approach; joint loading; implants materials; preclinical testing and analysis. Enroll Info: None

Requisites: Senior standing and (M E 306 or E M A 303), or graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2021

B M E/M E 415 – BIOMECHANICS OF HUMAN MOVEMENT

3 credits.

An overview of experimental and modeling techniques used to study human movement. Specific topics will include locomotion, motion capture systems, force plates, muscle mechanics, musculoskeletal modeling, three dimensional kinematics, inverse dynamics, forward dynamic simulation and imaging based biomechanics. Homework and laboratory activities emphasize applications of movement biomechanics in orthopedics and rehabilitation. Enroll Info: None

Requisites: B M E 315 and M E 340, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2021

B M E/PHM SCI 430 – BIOLOGICAL INTERACTIONS WITH MATERIALS

3 credits.

Addresses the range of materials currently being utilized for various biomedical applications, the biological systems governing biomaterial applications, analytical techniques pertinent to biomaterial evaluation, and selected major medical applications in which biomaterials play an important role. Enroll Info: None

Requisites: (ZOOLOGY/BIOLOGY 101 and 102, ZOOLOGY/BIOLOGY/BOTANY 151, ZOOLOGY 153, or BIOCORE 383) and (CHEM 341 or 343)

Repeatable for Credit: No

Last Taught: Spring 2022

B M E/E C E 462 – MEDICAL INSTRUMENTATION

3 credits.

Design and application of electrodes, biopotential amplifiers, biosensors, therapeutic devices. Medical imaging. Electrical safety. Measurement of ventilation, blood pressure and flow. Enroll Info: None

Requisites: E C E 340, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2021

B M E/E C E 463 – COMPUTERS IN MEDICINE

3 credits.

Study of microprocessor-based medical instrumentation. Emphasis on real-time analysis of electrocardiograms. Labs and programming project involve design of biomedical digital signal processing algorithms. Knowledge of computer programming language like C, C++ or Java, strongly encouraged. Enroll Info: None

Requisites: E C E 330 and (COMP SCI 200, 220, 300, or 301), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

B M E 489 – HONORS IN RESEARCH

1-3 credits.

Biomedical engineering undergraduate honors research projects supervised by faculty members. Enroll Info: None

Requisites: Consent of instructor**Course Designation:** Honors - Honors Only Courses (H)**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Fall 2021**B M E/H ONCOL/MED PHYS/PHYSICS 501 – RADIATION PHYSICS AND DOSIMETRY**

3 credits.

Interactions and energy deposition by ionizing radiation in matter; concepts, quantities and units in radiological physics; principles and methods of radiation dosimetry. Enroll Info: None

Requisites: MATH 234 and (PHYSICS 241 or 249) or graduate/professional standing**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No**Last Taught:** Fall 2021**B M E/M E 505 – BIOFLUIDICS**

3 credits.

Introduction to the physics of biological fluid flow with an emphasis on the cardiovascular system including blood rheology, pulsatile flow, wave travel, and topics relevant to blood flow measurement and biomedical device design. Enroll Info: None

Requisites: B M E 330, CBE 320, M E 363, graduate/professional standing, or member of Engineering Guest Students**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2022**B M E 510 – INTRODUCTION TO TISSUE ENGINEERING**

3 credits.

Overview of tissue engineering, including discussion of cell sources, cell-material interactions, tailoring biomaterials, methods of culture and characterization of engineering tissues, ethical issues, concluding with case studies of specific types of tissue engineering. Optional laboratory exercises offered throughout semester. Enroll Info: None

Requisites: B M E/PHM SCI 430, graduate/professional standing, or member of Engineering Guest Students**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2021**B M E 511 – TISSUE ENGINEERING LABORATORY**

1 credit.

Tissue engineering refers to the generation of biological substitutes to restore, maintain, or improve tissue function. Laboratory techniques are multi-disciplinary, from basic biological sciences, engineering, and biotechnology. Engineering approaches and analysis will be applied to these techniques. Enroll Info: None

Requisites: B M E 510 or concurrent enrollment, or graduate/professional standing**Repeatable for Credit:** No**Last Taught:** Fall 2021**B M E 515 – THERAPEUTIC MEDICAL DEVICES**

1 credit.

Design of medical devices to treat pathology. Enroll Info: None

Requisites: Junior standing and (ZOOLOGY/BIOLOGY 101 and 102, ZOOLOGY/BIOLOGY/BOTANY 151, ZOOLOGY 153, or BIOCORE 381), graduate/professional standing, or member of Engineering Guest Students**Repeatable for Credit:** No**Last Taught:** Spring 2019**B M E 517 – BIOLOGY IN ENGINEERING SEMINAR**

1 credit.

Current topics at the interface of biology and engineering with special emphasis on the ways in which engineers have contributed to knowledge and advances in biology. Enroll Info: None

Requisites: Junior standing and (ZOOLOGY/BIOLOGY 101 and 102, ZOOLOGY/BIOLOGY/BOTANY 151, ZOOLOGY 153, or BIOCORE 381), graduate/professional standing, or member of Engineering Guest Students**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2022**B M E 520 – STEM CELL BIOENGINEERING**

3 credits.

Covers engineering approaches that are used to understand and manipulate stem cells. Concepts covered include: introduction to stem cell biology, quantitative modeling of stem cell signaling, methods to engineer the stem cell microenvironment, and the role of stem cells in tissue development and regeneration. Enroll Info: None

Requisites: (MATH 319 or 320), (ZOOLOGY 470, 570, or BIOCORE 383), and (CHEM 341 or 343), graduate/professional standing, or member of Engineering Guest Students**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2022

B M E/MED PHYS 530 – MEDICAL IMAGING SYSTEMS

3 credits.

2D Fourier image representation, sampling, and image filtering with applications in medical imaging. Principles of operation, impulse responses, signal-to-noise, resolution and design tradeoffs in projection radiography, tomography, nuclear medicine, ultrasound, and magnetic resonance imaging. Enroll Info: None

Requisites: Graduate/professional standing or (E C E 330 or MED PHYS/ B M E 573)

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

B M E/MED PHYS 535 – INTRODUCTION TO ENERGY-TISSUE INTERACTIONS

3 credits.

Explore physical interactions between thermal, electromagnetic and acoustic energies and biological tissues with emphasis on therapeutic medical applications. Enroll Info: None

Requisites: PHYSICS 202, 208, 248, or PHYSICS/MED PHYS 265, or graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2017

B M E 545 – ENGINEERING EXTRACELLULAR MATRICES

3 credits.

Overview of the structure, function and biophysical properties of extracellular matrix (ECM) proteins, followed by discussion of how control or manipulation of ECM protein expression and distribution impacts on cell and tissue function, concluding with impacts of engineering ECM for regenerative medicine. Enroll Info: None

Requisites: B M E/PHM SCI 430, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

B M E 550 – INTRODUCTION TO BIOLOGICAL AND MEDICAL MICROSYSTEMS

3 credits.

Introduction to the field of MEMS (Micro-Electro-Mechanical-Systems), as it applies to biology and medicine. Topics will cover methodology of traditional MEMS devices, how they can be incorporated with biological systems, and methods for micro-structuring biological materials. Enroll Info: None

Requisites: B M E 310 and (ZOOLOGY/BIOLOGY 101 and 102, ZOOLOGY/BIOLOGY/BOTANY 151, ZOOLOGY 153, or BIOCORE 383), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2021

B M E 556 – SYSTEMS BIOLOGY: MAMMALIAN SIGNALING NETWORKS

3 credits.

Introduction to the experimental and mathematical modeling techniques used in systems biology through lectures and critical analyses of relevant publications with a primary focus on gene/protein networks and mammalian systems. Enroll Info: None

Requisites: (MATH 319, 320, or 375), (B M E 510, ZOOLOGY 470, 523, 570, or BIOCORE 383) and Junior Standing, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

B M E/CBE 560 – BIOCHEMICAL ENGINEERING

3 credits.

Properties of biological molecules; enzyme kinetics, enzyme reactors, and enzyme engineering; metabolic engineering; microbial growth kinetics; bioreactor design; bioseparations. Enroll Info: None

Requisites: Junior standing and (ZOOLOGY/BIOLOGY 101 and 102, ZOOLOGY/BIOLOGY/BOTANY 151, ZOOLOGY 153, or BIOCORE 383), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Sustain - Sustainability

Repeatable for Credit: No

Last Taught: Fall 2021

B M E/ I SY E 564 – OCCUPATIONAL ERGONOMICS AND BIOMECHANICS

3 credits.

Introduces engineers how to design manufacturing and industrial operations in which people play a significant role, so that human capabilities are maximized, physical stress is minimized, and workload is optimized. Examples and topics emphasize industrial applications. Enroll Info: None

Requisites: PSYCH/ I SY E 349 or B M E 315, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

B M E/MED PHYS 566 – PHYSICS OF RADIOTHERAPY

3 credits.

Ionizing radiation use in radiation therapy to cause controlled biological effects in cancer patients. Physics of the interaction of the various radiation modalities with body-equivalent materials, and physical aspects of clinical applications. Enroll Info: None

Requisites: PHYSICS/B M E/H ONCOL/MED PHYS 501

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

B M E/MED PHYS 567 – THE PHYSICS OF DIAGNOSTIC RADIOLOGY
4 credits.

Physics of x-ray diagnostic procedures and equipment, radiation safety, general imaging considerations; lecture and lab. Enroll Info: None

Requisites: MATH 234 and (PHYSICS 241 or 249) or graduate/professional standing

Course Designation: Breadth - Biological Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2018

B M E/MED PHYS 568 – MAGNETIC RESONANCE IMAGING (MRI)
2 credits.

Core course covering the physics associated with magnetic resonance imaging emphasizing techniques employed in medical diagnostic imaging. Major MRI topics include: physics of MR, pulse sequences, hardware, imaging techniques, artifacts, and clinical applications. At the completion of this course, students should have an understanding of the technical and scientific details of modern magnetic resonance imaging and its use in diagnosing disease. Graduate students who have not taken MATH 222 and PHYSICS 202 at UW-Madison must have the equivalent coursework in order to be successful in this course. Enroll Info: None

Requisites: Graduate/professional standing or (MATH 222 and PHYSICS 202, 208, 241, 244, 248 or 249)

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

B M E/MED PHYS 573 – MEDICAL IMAGE SCIENCE: MATHEMATICAL AND CONCEPTUAL FOUNDATIONS
3 credits.

The conceptual and mathematical foundations of medical imaging, including both deterministic and stochastic aspects. Enroll Info: None

Requisites: MATH 234, 319 and (PHYSICS 202 or 208) or graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2021

B M E/MED PHYS 574 – IMAGING IN MEDICINE: APPLICATIONS
3 credits.

Builds on the fundamental conceptual and mathematical foundations addressed in MED PHYS/B M E 573, with application of concepts to practical medical imaging problems and emerging quantitative imaging techniques. Enroll Info: None

Requisites: MED PHYS/B M E 573

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

B M E/MED PHYS 575 – DIAGNOSTIC ULTRASOUND IMAGING
2 credits.

Propagation of ultrasonic waves in biological tissues; principles of ultrasonic measuring and imaging instrumentation; design and use of currently available tools for performance evaluation of diagnostic instrumentation; biological effects of ultrasound. Enroll Info: None

Requisites: Graduate/professional standing or (MATH 234, 319, or 320 and PHYSICS 202 or 208)

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2019

B M E/MED PHYS 578 – NON-IONIZING DIAGNOSTIC IMAGING
4 credits.

Covers the physics associated with magnetic resonance imaging and diagnostic ultrasound emphasizing techniques employed in medical diagnostic imaging. Major MRI topics include: physics of MR, pulse sequences, hardware, imaging techniques, artifacts, and spectroscopic localization. Ultrasound based topics covered include: propagation of ultrasonic waves in biological tissues, principles of ultrasonic measuring and imaging instrumentation, design and use of currently available tools for performance evaluation of diagnostic instrumentation, and biological effects of ultrasound. Gain an understanding of the technical and scientific details of modern non-ionizing medical magnetic resonance and ultrasound devices and their use in diagnosing disease. Enroll Info: None

Requisites: MATH 234, (MATH 319 or 320) and (PHYSICS 202, 208, 241 or 248), or graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

B M E/MED PHYS 580 – THE PHYSICS OF MEDICAL IMAGING WITH IONIZING RADIATION
4 credits.

Concepts and principles on the physics of medical imaging systems that form images using high energy photons are presented. Such systems are divided into two categories: (1) those based on the transmission of x-rays through the human body, including radiography, mammography, fluoroscopy, and computed tomography (CT), and (2) those based on the emission of gamma rays or annihilation radiation following radioactive decay of an internal radiolabeled molecule, including the gamma camera, single photon emission tomography (SPECT), and positron emission tomography (PET) and PET hybrid imaging systems. Emphasis is placed on understanding how physics, system design, and imaging technique determine image performance metrics such as contrast, signal-to-noise ratio, and spatial resolution. Clinical applications and radiation safety concepts are detailed for the different types of imaging systems. Enroll Info: None

Requisites: PHYSICS/B M E/H ONCOL/MED PHYS 501 and MED PHYS/B M E 573

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

B M E 601 – SPECIAL TOPICS IN BIOMEDICAL ENGINEERING

1-3 credits.

Directed study projects as arranged with instructor. Enroll Info: None

Requisites: None**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2022**B M E 602 – SPECIAL TOPICS IN BIOMEDICAL ENGINEERING**

1-3 credits.

Special topics in biomedical engineering for graduate students or both graduate and undergraduate students together. Enroll Info: None

Requisites: None**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2022**B M E/M E 603 – TOPICS IN BIO-MEDICAL ENGINEERING**

1-3 credits.

Various aspects of living systems of interest to the mechanical engineer, such as the mechanics of hearing and vision, cardiac and central nervous systems, artificial organs, blood flow behavior, and energy-transfer processes. Enroll Info: None

Requisites: None**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2022**B M E/M E 615 – TISSUE MECHANICS**

3 credits.

Focus on solid mechanics of prominent musculoskeletal and cardiovascular tissues. Their normal and pathological behaviors (stiffness, strength, relaxation, creep, adaptive remodeling, etc.) in response to physiologic loading will be examined and quantified. Enroll Info: None

Requisites: M E 306 or E M A 303, or graduate/professional standing, or member of Engineering Guest Students**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2021**B M E/MED PHYS/PHMCO-M/PHYSICS/RADIOL 619 – MICROSCOPY OF LIFE**

3 credits.

Survey of state of the art microscopic, cellular and molecular imaging techniques, beginning with subcellular microscopy and finishing with whole animal imaging. Enroll Info: None

Requisites: PHYSICS 104, 202, 208, or 248 or PHYSICS/MED PHYS 265**Course Designation:** Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No**Last Taught:** Fall 2021**B M E 630 – NANOMATERIALS FOR BIOMEDICAL APPLICATIONS**

3 credits.

An in-depth discussion of the chemistry, structure, synthesis/fabrication, and properties of various types of nanomaterials (e.g., liposomes, polymer micelles, polymersomes, dendrimers, and a number of inorganic nanoparticles) and their applications in therapeutics (e.g., drug and gene delivery), diagnostics (e.g. biosensing and molecular imaging), and tissue engineering. Enroll Info: None

Requisites: CBE 510 or graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2021**B M E/I SY E 662 – DESIGN AND HUMAN DISABILITY AND AGING**

3 credits.

Design of products for persons with physical, sensory or cognitive impairments is covered as well as the design of standard mass market products. Interdisciplinary teams explore specific disabilities, then design a standard mass market product in competition with each other. Enroll Info: None

Requisites: Junior standing or member of Engineering Guest Students**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2022**B M E/CRB 670 – BIOLOGY OF HEART DISEASE AND REGENERATION**

3 credits.

Presents diverse topics in contemporary heart biology to facilitate understanding of biological, mechanistic, and experimental concepts of cardiac physiology, disease, and regeneration. Learn cellular and molecular mechanisms underlying heart physiology, function, disease and regenerative ability in various model systems. Includes thinking critically about methodology, experimental design and interpretation, and how conclusions are reached in heart biology through cutting-edge literature. Enroll Info: None

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2021**B M E 701 – SEMINAR IN BIOMEDICAL ENGINEERING**

0 credits.

Speakers present current research, reviews of previous research, or topics of interest to biomedical engineering graduate students and faculty.

Enroll Info: None

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2022

B M E 702 – GRADUATE COOPERATIVE EDUCATION PROGRAM

1-2 credits.

Work experience that combines classroom theory with practical knowledge of operations to provide students with a background on which to develop and enhance a professional career. The work experience is tailored for MS students from within the U.S. as well as eligible international students. Enroll Info: None

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Fall 2021**B M E 703 – RESPONSIBLE CONDUCT OF RESEARCH FOR BIOMEDICAL ENGINEERS**

2 credits.

Develop an understanding of the elements involved in being a responsible member of the Biomedical Engineering research community. Topics include mentor/mentee relationships, identifying research problems, research integrity, ethics, regulations, and improving the scientific climate. Enroll Info: None

Requisites: Declared in Biomedical Engineering, Ph.D. or Biomedical Engineering: Research, M.S.**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2021**B M E/MED PHYS 710 – ADVANCES IN MEDICAL MAGNETIC RESONANCE**

3 credits.

Addresses the theory and applications of magnetic resonance (MR) in medicine, by providing the necessary theoretical background to understand advanced MR techniques including magnetic resonance imaging (MRI). Enroll Info: None

Requisites: MED PHYS/B M E 568**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2021**B M E/CHEM/MED PHYS 750 – BIOLOGICAL OPTICAL MICROSCOPY**

3 credits.

Covers several aspects of state-of-the-art biological and biophysical imaging with an emphasis on instrumentation, beginning with an overview of geometrical optics and optical and fluorescence microscopy. The bulk of the course will focus on advanced imaging techniques including nonlinear optical processes (multi-photon excitation, second harmonic generation, and stimulated Raman processes) and emerging super-resolution methods. Special emphasis will be given to current imaging literature and experimental design. Enroll Info: Knowledge of physics-based optics [such as PHYSICS 202] strongly recommended.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2021**B M E 751 – BIOMEDICAL OPTICS AND BIOPHOTONICS**

3 credits.

The study and use of light in the life sciences. Interactions of light with cells and tissue can be used for imaging, measurement, diagnosis, and therapy. Applications include optical imaging, endoscopy, microscopy, resolution enhancement, adaptive optics, Optical Coherence Tomography (OCT), quantitative phase microscopy, spectroscopy (fluorescence, elastic scattering), diffuse optical tomography, and computational modeling of light transport in tissue. Fundamental skills, concepts, and theory used for these applications include geometric optics, lens design, Fourier transforms, polarization, interference, coherence, and scattering theory. Particular emphasis will be placed on current literature and cutting edge instruments and methods. Enroll Info: None

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2021**B M E/MED PHYS/PHYSICS 775 – ADVANCED ULTRASOUND PHYSICS**

3 credits.

Foundations of acoustic wave equations, diffraction phenomena and acoustic beam formation, models for acoustic scattering from discrete structures and inhomogeneous continua, speckle statistics including speckle correlation, applications of these topics in medical imaging. Enroll Info: None

Requisites: Consent of instructor**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2013**B M E/E C E/MED PHYS 778 – MACHINE LEARNING IN ULTRASOUND IMAGING**

3 credits.

Concepts and machine learning techniques for ultrasound beamforming for image formation and reconstruction to image analysis and interpretation will be presented. Key machine learning and deep learning concepts applied to beamforming, compressed sampling, speckle reduction, segmentation, photoacoustics, and elasticity imaging will be evaluated utilizing current peer-reviewed publications. Enroll Info: None

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2021

B M E 780 – METHODS IN QUANTITATIVE BIOLOGY

1 credit.

Focuses on understanding the key methods and principles of quantitative biology through a close reading of the primary literature. Topics covered will include deterministic and stochastic methods for modeling cellular systems, techniques in systems and synthetic biology, image processing tools and image analysis for biology, data-driven network models, genomic approaches, single-molecule approaches, and key computational biology tools. This course is intended for graduate students from a variety of backgrounds who are interested in pursuing quantitative biology during their graduate studies. Enroll Info: None

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2021**B M E/CBE 782 – MODELING BIOLOGICAL SYSTEMS**

3 credits.

Literature survey of mathematical models in biology at the molecular and cellular levels; application of chemical kinetics and thermodynamics to biological systems; comparison of deterministic and stochastic strategies. Enroll Info: None

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2015**B M E/CBE 783 – DESIGN OF BIOLOGICAL MOLECULES**

3 credits.

Introduction to the methodologies for engineering the structure and function of biological molecules, especially proteins. Develop an understanding for the integration of computation and experiment to address biological molecular engineering problems. Enroll Info: Knowledge of biochemistry and cell biology [such as BIOCHEM 501 or ZOOLOGY 570] required.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2019**B M E 790 – MASTER'S RESEARCH AND THESIS**

1-9 credits.

Under faculty supervision. Enroll Info: None

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2022**B M E 799 – ADVANCED INDEPENDENT STUDY**

1-5 credits.

Under faculty supervision. Enroll Info: None

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2022**B M E/PHM SCI 801 – SEMINAR ON DEVELOPMENT OF MEDICAL DEVICES AND DRUGS**

1 credit.

An overview of three major sectors of medical product and technology development including pharmaceuticals, medical devices and combination products. Regulatory framework, disclosure and patenting, technical design and development strategy, academia-specific development challenges will be among the major lecture topics. Enroll Info: None

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**B M E 890 – PRE-DISSERTATION RESEARCH**

1-9 credits.

Under faculty supervision. Enroll Info: None

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2022**B M E/B M I/BIOCHEM/CBE/COMP SCI/GENETICS 915 – COMPUTATION AND INFORMATICS IN BIOLOGY AND MEDICINE**

1 credit.

Participants and outside speakers will discuss current research in computation and informatics in biology and medicine. This seminar is required of all CIBM program trainees. Enroll Info: None

Requisites: Consent of instructor**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2022**B M E 990 – RESEARCH AND THESIS**

1-9 credits.

Under faculty supervision. Enroll Info: None

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2022

B M E 999 – ADVANCED INDEPENDENT STUDY

1-9 credits.

Under faculty supervision. Enroll Info: None

Requisites: Declared in Biomedical Engineering PhD or professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2019