Biomedical Engineering (BMEG)

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Biomedical Engineering Website (http://biomedical-engineering.uark.edu/)

Biomedical engineering encompasses the creation, design, and operation, of processes / technology related to the broad field of human healthcare. The profession traditionally has focused on applications related to the development of instrumentation and diagnostic equipment, discovery of novel treatment options, production of new therapeutics, and the elucidation of underlying biophysical phenomena. Newer applications of bioengineering take advantage of the ever deepening understanding of human physiology and molecular genetics, as related to prevention, detection, and treatment of medical conditions. The program objectives of the Biomedical Engineering undergraduate program are to produce graduates who are capable of:

- Succeeding in practice at the interface between life science and engineering, in other professional activities, or in post-baccalaureate studies, and
- Utilizing their engineering education/experience in creating new knowledge or enabling technologies for improvement of human health and healthcare, and
- Conducting themselves with high standards of professional ethics and integrity, and
- Being aware of the limits of their knowledge and initiate self-directed learning to create future professional opportunities for themselves in biomedical engineering.

Completion of the degree requirements provides for the following educational outcomes and ability to:

- Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- Apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- Communicate effectively with a range of audiences
- Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
- Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusion
- Acquire and apply new knowledge as needed, using appropriate learning strategies.

These educational outcomes are experienced within the context of biology and physiology appropriate to solving problems at the interface of engineering and biology.

Requirements for B.S. in Biomedical Engineering

Technical Options in Biomedical Engineering

Each student in biomedical engineering is required to complete nine semester hours of biomedical engineering technical electives. Biomedical engineering technical elective courses must be selected from a faculty-approved list of courses found in the department's Undergraduate Advising Handbook, which is available on the department's website (http://biomedical-engineering.uark.edu/). Elective courses are chosen with the aid of an academic adviser to better prepare for employment or further study in areas such as:

- Bioengineering
- Pharmaceutical manufacturing or pharmacology
- Biomedical device design
- Medicine
- Business
- Law

Technical Elective Course

Each student in biomedical engineering is required to complete three semester hours of upper level science electives. Upper level (3000 and above) science electives will be chosen from courses in mathematics, engineering, and the sciences with the approval of their adviser. The department maintains a list of approved upper level science electives that may be found in the department's Undergraduate Advising Handbook, which is available on the department's website (http://biomedical-engineering.uark.edu/).

Biomedical Engineering B.S.Bm.E. Eight-Semester Degree Program

The following section contains the list of courses required for the Bachelor of Science in Biomedical Engineering degree and a suggested sequence for students who enter the College through the Freshman Engineering Program. Not all courses are offered every semester, so students who deviate from the suggested sequence must pay careful attention to course scheduling and course prerequisites. Students wishing to follow the eight-semester degree plan should see the Eight-Semester Degree Policy (http://catalog.uark.edu/undergraduatecatalog/academicregulations/eightsemesterdegreecompletionpolicy/) in the Academic Regulations chapter for university requirements of the program.

First Year	Units	
	Fall	Spring
ENGL 1013 Composition I (ACTS Equivalency = ENGL 1013) (Satisfies General Education Outcome 1.1)	3	
MATH 2554 Calculus I (ACTS Equivalency = MATH 2405) (Satisfies General Education Outcome 2.1)[1]	4	
CHEM 1103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture)	3	
GNEG 1111 Introduction to Engineering I	1	
Select one of the following to satisfy General Education Outcome 4.2:		

HIST 2003 History of the American People to 1877 (ACTS Equivalency = HIST 2113) or HIST 2013 History of the American People, 1877 to Present (ACTS Equivalency = HIST 2123) or PLSC 2003 American National Government (ACTS Equivalency = PLSC 2003)	3	
ENGL 1033 Technical Composition II (ACTS Equivalency = ENGL 1023) (Satisfies General Education Outcome 1.2)		3
Freshman Science Elective with lab[2]		4
MATH 2564 Calculus II (ACTS Equivalency = MATH 2505)		4
PHYS 2054 University Physics I (ACTS Equivalency = PHYS 2034)		4
GNEG 1121 Introduction to Engineering II		1
Year Total:	14	16

Second Year	**Fall**	**Spring**
Sophomore Science Elective with lab[3]	4	
BMEG 2614 Introduction to Biomedical Engineering	4	
MATH 3083 Linear Algebra	3	
Satisfies General Education Outcome 3.4:		
BIOL 1543 Principles of Biology (ACTS Equivalency = BIOL 1014 Lecture) & BIOL 1541L Principles of Biology Laboratory (ACTS Equivalency = BIOL 1014 Lab)	4	
BMEG 2813 Biomechanical Engineering		3
BMEG 2904 Biomedical Instrumentation (with Lab)		4
MATH 2584 Elementary Differential Equations		4
BIOL 2533 Cell Biology		3
Fine Arts State Minimum Core Elective (Satisfies General Education Outcome 3.1)[4]		3
Year Total:	15	17

Third Year	**Fall**	**Spring**
BMEG 3634 Biomaterials (with lab)	4	
BMEG 3124 Biomedical Signals and Systems (with lab)	4	
CHEG 2313 Thermodynamics of Single-Component Systems or MEEG 2403 Thermodynamics	3	
CHEM 3603 Organic Chemistry I & CHEM 3601L Organic Chemistry I Laboratory	4	
Social Sciences State Minimum Core Elective (Satisfies General Education Outcomes 3.3 and 4.1)[5]	3	
BMEG 3653 Biomedical Modeling and Numerical Methods		3
BMEG 3824 Biomolecular Engineering (with lab)		4
BMEG 3801 Clinical Observations and Needs Finding		1
CHEG 2133 Fluid Mechanics or MEEG 3503 Mechanics of Fluids		3
BIOL 2213 Human Physiology (ACTS Equivalency = BIOL 2414 Lecture) & BIOL 2211L Human Physiology Laboratory (ACTS Equivalency = BIOL 2414 Lab)		4
STAT 2823 Biostatistics		3
Year Total:	18	18

Fourth Year	**Fall**	**Spring**
BMEG 4813 Biomedical Engineering Design I	3	
BMEG 4623 Biomedical Transport Phenomena	3	
BMEG Elective	3	
Science Elective	3	
Social Sciences State Minimum Core Elective (Satisfies General Education Outcome 3.3)[6]	3	
BMEG 4823 Biomedical Engineering Design II (Satisfies General Education Outcome 6.1)		3
BMEG Elective		3
BMEG Elective		3
Social Sciences State Minimum Core Elective (Satisfies General Education Outcome 3.3)[6]		3
Humanities State Minimum Core Elective (Satisfies General Education Outcomes 3.2 and 5.1)[7]		3
Year Total:	15	15

Total Units in Sequence:	**128**

1 Students have demonstrated successful completion of the learning indicators identified for learning outcome 2.1, by meeting the prerequisites for MATH 2554.

2 The Freshman Science Elective must be chosen from either CHEM 1123/CHEM 1121L or PHYS 2074.

3 The Sophomore Science Elective must be either PHYS 2074 or CHEM 1123/CHEM 1121L. (Whichever was not chosen as the Freshman Engineering Science Elective).

4 The Fine Arts Elective courses which satisfy General Education Outcome 3.1 include: ARCH 1003, ARHS 1003, COMM 1003, DANC 1003, LARC 1003, MLIT 1003, MLIT 1003H, MLIT 1013, MLIT 1013H, MLIT 1333, THTR 1003, THTR 1013, or THTR 1013H.

5 The Social Sciences Elective courses which satisfy General Education Outcomes 3.3 and 4.1 include: ANTH 1023, COMM 1023, HDFS 1403, HDFS 2413, HIST 1113, HIST 1123, HIST 2093, HUMN 1114H, HUMN 2114H, INST 2013, INST 2813, INST 2813H, PLSC 2013, PLSC 2813, PLSC 2813H, RESM 2853, SOCI 2013, SOCI 2013H, or SOCI 2033.

6 The Social Sciences Elective courses which satisfy General Education Outcome 3.3 include: AGEC 1103, AGEC 2103, ANTH 1023, COMM 1023, ECON 2013, ECON 2023, ECON 2143, EDST 2003, HDFS 1403, HDFS 2413, HDFS 2603, HIST 1113, HIST 1113H, HIST 1123,HIST 1123H, HIST 2003, HIST 2013, HIST 2093, HUMN 1114H, HUMN 2114H, INST 2813, INST 2813H, PLSC 2003, PLSC 2013, PLSC 2203, PLSC 2813, PLSC 2813H, PSYC 2003, RESM 2853, SOCI 2013, SOCI 2013H, or SOCI 2033. Note, courses cannot be counted twice in degree requirements.

7 The Humanities Elective courses which satisfy General Education Outcomes 3.2 and 5.1 include: CLST 1003, CLST 1003H, CLST 1013, HUMN 1124H, PHIL 2003, PHIL 2003C, PHIL 2003H, PHIL 2103, or PHIL 2103C.

Biomedical Engineering Technical Electives

BMEG 4103L		3
BMEG 4213	Tissue Mechanics	3
BMEG 4243	Advanced Biomaterials and Biocompatibility	3
BMEG 4403	Biomedical Microscopy	3
BMEG 4413	Tissue Engineering	3
BMEG 450VH	Honors Thesis	1-4
BMEG 460V	Individual Study	1-3
BMEG 460VH	Honors Individual Study	1-3
BMEG 4873		3
BMEG 4973	Regenerative Medicine	3
BMEG 470V	Special Topics in Biomedical Engineering	1-4

Honors Program Requirements

Students enrolled in the Honors College who are to receive the Bachelor of Science in Biomedical Engineering must complete a minimum of 12 hours of honors credit. At least 6 hours must be completed within the Biomedical Engineering program including at least 3 hours resulting in an Honors Thesis. The BMEG honors courses are acceptable as engineering electives and in some cases may be substituted for required courses.

Abbas, James, Ph.D., M.S. (Case Western Reserve University), Sc.B. (Brown University), Professor, 2021.
Balachandran, Kartik, Ph.D., M.S. (Georgia Institute of Technology), B.S. (National University of Singapore), Associate Professor, 2012, 2018.
Elsaadany, Mostafa, Ph.D. (University of Toledo), Teaching Assistant Professor, 2019.
Harris, Leonard, Ph.D. (Cornell University), B.S. (University of Colorado, Boulder), Assistant Professor, 2020.
Jensen, Hanna Katariina, Ph.D. (University of Oulu, Finland), Research Assistant Professor, 2015.
Jensen, Morten O., Ph.D. (University of Aarhus, Denmark), M.Sc. (Georgia Institute of Technology), Associate Professor, 2014.
Muldoon, Timothy J., M.D. (Baylor College of Medicine), Ph.D. (Rice University), B.S. (Johns Hopkins University), Associate Professor, 2012, 2018.
Nelson, Christopher, Ph.D. (Vanderbilt University), Assistant Professor, 2019.
Puvanakrishnan, Priyaveena, Ph.D. (University of Texas at Austin), Instructor, 2015.
Qian, Xianghong, Ph.D., M.Phil. (George Washington University), B.S. (Nanjing University, P.R. China), Professor, 2011, 2016.
Quinn, Kyle P., Ph.D. (University of Pennsylvania), B.S. (University of Wisconsin), Assistant Professor, 2014.
Rajaram, Narasimhan, Ph.D. (University of Texas, Austin), B.E. (Anna University, India), Assistant Professor, 2014.
Rao, Raj R., Ph.D. (University of Georgia), M.S. (University of Texas), M.Sc., B.E. (Birla Institute of Technology and Sciences, India), Professor, 2016.
Samsonraj, Rebekah M., Ph.D. (Cornell University), B.S. (University of Colorado, Boulder), Assistant Professor, 2020.
Song, Young Hye, Ph.D. (Cornell University), Assistant Professor, 2019.
Wolchok, Jeffrey Collins, Ph.D. (University of Utah), M.S., B.S. (University of California at Davis), Associate Professor, 2011, 2017.

Courses

BMEG 2614. Introduction to Biomedical Engineering. 4 Hours.
An introductory course for undergraduate biomedical engineering students. It covers topics such as recombinant DNA technologies, cell and tissue engineering, stem cell and organ regeneration, the biomechanics, bioinstrumentation, engineering of immunity, and bio- and medical imaging, etc. The application of nano-biotechnology in developing clinical products such as tissue engineered products, drug delivery systems, etc. will be emphasized in the course. Prerequisite: (GNEG 1321H, or GNEG 1121, or GNEG 1103), and CHEM 1103, with a grade of C or better, MATH 2554 and PHYS 2054. (Typically offered: Fall and Summer)

BMEG 2813. Biomechanical Engineering. 3 Hours.
This course introduces basic concepts and principles of biomechanics to biomedical and other engineering students. The course topics include mechanics and materials, viscoelastic properties, bone, cartilage, ligament, tendon, muscle, cardiovascular dynamics, clinical gait analysis, etc. After taking this course, students are expected to understand the application of engineering kinetics to describe motions of human body and mechanic properties of tissues. MATLAB will be used to write and solve biomechanical static and dynamic equations. Lecture 3 hours per week. Prerequisite: BMEG 2614, CHEM 1123, MATH 2564, and PHYS 2074. (Typically offered: Spring)

BMEG 2904. Biomedical Instrumentation. 4 Hours.
This course is designed for biomedical engineering undergraduate students to learn both theoretical and practical concepts of bioinstrumentation and their applications in modern life science and medicine. Analytical experiments will be practiced in the laboratory along with the lecture section. This course covers basic topics in circuits such as charge current, voltage, resistance, power energy, linear network analysis, inductors, capacitors, operational amplifier, time-varying signals, active analog filters, bioinstrumentation design etc. The application of these principles and theories in bioinstrumentation design and development is particularly emphasized in this course. The lab section requires team work, planning, and data sharing. Corequisite: Lab component. Prerequisite: BMEG 2614, MATH 2564 and PHYS 2074. (Typically offered: Spring)

BMEG 3124. Biomedical Signals and Systems. 4 Hours.
This course will introduce students to the basics of signals - continuous and digital signals, and signal processing tools, such as filters, Laplace and Fourier transforms. The 'systems' aspect of the course will focus on physiological systems and methods to model such systems. The course will also focus on the biomedical applications of these methods through lab components. Prerequisite: BMEG 2904. (Typically offered: Fall)

BMEG 3634. Biomaterials. 4 Hours.
Introduction to the engineering properties of materials used in biomedical devices and applications. Topics include: atomic properties, structure-property-processing relationships, bulk engineering properties, surface and interfacial properties and applications of materials in biology and medicine. All topics will be reviewed in the context of specific biomedical devices and the engineering principles involved in their design. Corequisite: Lab component. Prerequisite: BMEG 2813, CHEM 1123, and BIOL 1543 and BIOL 1541L. (Typically offered: Fall)

BMEG 3653. Biomedical Modeling and Numerical Methods. 3 Hours.
Application of mathematical techniques to physiological systems. The emphasis will be on cellular physiology and cardiovascular system. Cellular physiology topics include models of cellular metabolism, membrane dynamics, membrane potential, excitability, wave propagation and cellular function regulation. Cardiovascular system topics include models of blood cells, oxygen transport, cardiac output, cardiac regulation, and circulation. Pre- or Corequisite: MATH 2584. Prerequisite: BMEG 2614, and (MATH 2574 or MATH 3083). (Typically offered: Spring)

BMEG 3653H. Honors Biomedical Modeling and Numerical Methods. 3 Hours.
Application of mathematical techniques to physiological systems. The emphasis will be on cellular physiology and cardiovascular system. Cellular physiology topics include models of cellular metabolism, membrane dynamics, membrane potential, excitability, wave propagation and cellular function regulation. Cardiovascular system topics include models of blood cells, oxygen transport, cardiac output, cardiac regulation, and circulation. Pre- or Corequisite: MATH 2584. Prerequisite: BMEG 2614, and (MATH 2574 or MATH 3083). (Typically offered: Spring)
This course is equivalent to BMEG 3653.

BMEG 3801. Clinical Observations and Needs Finding. 1 Hour.
This course involves the introduction of clinical procedures and biomedical devices and technology to biomedical engineering students. Students will tour medical facilities, clinics and hospitals and will participate in medical seminars, workshops and medical rounds. The course prepares students to successfully select and complete a project in the senior capstone course. Prerequisite: The prerequisites for BMEG students are BMEG 2813 or BMEG 2904; prerequisites for DASC students: BMEG 2614 and DASC 2594. (Typically offered: Fall and Spring)

BMEG 3824. Biomolecular Engineering. 4 Hours.
Biomolecular Engineering is to design and produce biomolecules, especially proteins, for uses ranging from pharmaceuticals, materials, sensors, transducers, to functional interfaces with conventional engineering materials. The course begins with an introduction to the tools and techniques of molecular biology that are used for protein engineering. Additional topics include recombinant DNA techniques, biochemical kinetics, cell growth reaction and kinetics, bioreactors, membrane processes, and bioproduct purification. There is an associated laboratory with exercises related to lecture topics. Corequisite: Lab component. Prerequisite: BMEG 3634, CHEM 1123, and BIOL 2533. (Typically offered: Spring)

BMEG 3824H. Honors Biomolecular Engineering. 4 Hours.
Biomolecular Engineering is to design and produce biomolecules, especially proteins, for uses ranging from pharmaceuticals, materials, sensors, transducers, to functional interfaces with conventional engineering materials. The course begins with an introduction to the tools and techniques of molecular biology that are used for protein engineering. Additional topics include recombinant DNA techniques, biochemical kinetics, cell growth reaction and kinetics, bioreactors, membrane processes, and bioproduct purification. There is an associated laboratory with exercises related to lecture topics. Corequisite: Lab component. Prerequisite: BMEG 3634, CHEM 1123, and BIOL 2533. (Typically offered: Spring)
This course is equivalent to BMEG 3824.

BMEG 3913. Biofluid Mechanics. 3 Hours.
Introduction to fundamental concepts and applications of fluid dynamics from a biological and physiological perspective. Topics include physical properties of fluids, fluid statics, manometers, streamlines and the Bernoulli relation, velocity and acceleration fields, viscous flow and the Navier-Stokes equations, flows in pipes and over submerged surfaces, properties of blood and other physiological fluids, transport models in the lungs, lymph, blood, and artificial organs, and computational fluid dynamics (CFD) simulations. Prerequisite: MATH 2584, PHYS 2074, and BMEG 2614. (Typically offered: Fall)

BMEG 4213. Tissue Mechanics. 3 Hours.
The purpose of this course is to introduce students to non-linear biomechanics of soft tissues such as skin, bladder, blood vessels, and the brain. Topics covered: Tissue mechanics: continuum biomechanics, tensor analysis, kinematics of continua, balance laws. Governing physics of mechanics as applied to soft tissues. Various constitutive relations will be discussed: linear elastic, hyperelastic, viscoelastic, poroelastic, and inelastic materials with internal variables. Cannot receive credit for both BMEG 4213 and BMEG 5213. Prerequisite: BMEG 2813, BMEG major and Senior standing. (Typically offered: Irregular)

BMEG 4243. Advanced Biomaterials and Biocompatibility. 3 Hours.
From Absorbable sutures to Zirconium alloy hip implants, biomaterials science influences nearly every aspect of medicine. This course focuses on the study of different classes of biomaterials and their interactions with human tissues. Topics include: biocompatibility; biofouling; hemocompatibility; wound healing response; foreign body response; design of orthopedic, dental and cardiovascular implants; opthalmological and dermatological materials; degradable polymers for drug delivery; nanobiomaterials; smart biomaterials and the regulation of devices and materials by the FDA. Pre- or Corequisite: BMEG 4623. Prerequisite: BMEG 3634. (Typically offered: Irregular)

BMEG 4253. Biologics: Next Generation Therapeutics and Their Purification. 3 Hours.
The course focuses on the production and purification of biologics including monoclonal antibodies, viral vectors, nucleic acids and other biotherapeutics. In particular, the course will focus on the fundamental thermodynamics principles as well as kinetic limitations involved in upstream harvesting and downstream purification. Applications of PCR, mass spectroscopy, electrophoresis, imaging and modeling tools during the production and purification of biologics will be discussed. (Typically offered: Irregular)

BMEG 4403. Biomedical Microscopy. 3 Hours.
An advanced course covering light microscopy techniques, conjugate image planes, principles of contrast, fluorescence imaging, confocal and multi-photon microscopy, electron microscopy, atomic force microscopy, image reconstruction and digital image processing with supporting units in tissue culture and histology. Prerequisite: The prerequisites for BMEG students are BMEG 2904, PHYS 2074, BMEG major and Senior standing; prerequisites for DASC students: BMEG 2614, PHYS 2054 and DASC 2113. (Typically offered: Irregular)

BMEG 4413. Tissue Engineering. 3 Hours.
This course introduces Tissue Engineering approaches at genetic and molecular, cellular, tissue, and organ levels. Topics include cell and tissue in vitro expansion, tissue organization, signaling molecules, stem cell and stem cell differentiation, organ regeneration, biomaterial and matrix for tissue engineering, bioreactor design for cell and tissue culture, dynamic and transportation in cell and tissue cultures, clinical implementation of tissue engineered products, and tissue-engineered devices. Prerequisite: BMEG 3824 and BIOL 2533. (Typically offered: Irregular)

BMEG 450VH. Honors Thesis. 1-4 Hour.
Provides Biomedical Engineering students an opportunity to explore a topic in depth through an independent research or design project. Prerequisite: Honors standing. (Typically offered: Spring and Summer) May be repeated for degree credit.

BMEG 4513. Biomedical Optics and Imaging. 3 Hours.
This course will provide students with a fundamental understanding of various biomedical imaging modalities. Topics will include: Basics of light-tissue interaction - absorption, fluorescence, elastic and inelastic scattering; Computational and analytical models of light propagation to quantify tissue optical properties; Optical imaging techniques spectroscopy, tomography, and laser speckle with potential clinical applications; and Clinical imaging modalities and recent advances X-ray, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), Computed Tomography (CT), Ultrasound imaging, and Photoacoustic imaging. At the end of this course, students should have a good understanding of optical imaging, spectroscopy, and non-optical imaging modalities, specific anatomical sites that they are best suited for, and the trade-offs between imaging depth and resolution. Students may not receive credit for both BMEG 4513 and BMEG 5513. Prerequisite: The prerequisites for BMEG students are BMEG 2904 and senior standing; prerequisites for DASC students: BMEG 2614, PHYS 2054 and DASC 2113 and senior standing. (Typically offered: Irregular)

BMEG 4523. Biomedical Data and Image Analysis. 3 Hours.
This course focuses on an introduction to image processing and analysis for applications in biomedical research. After a review of basic MATLAB usage, students will learn fundamental tools for processing and analyzing data from a variety of subdisciplines within biomedical engineering. Topics include: filtering, thresholding, segmentation, morphological processing, and image registration. Through exercises involving 1D, 2D, and 3D data, students will develop problem-solving skills and a knowledge base in MATLAB required for customized quantitative data analysis. Students may not receive credit for both BMEG 4523 and BMEG 5523. Prerequisite: The prerequisites for BMEG students are BMEG 3124 and BMEG 3653; prerequisites for DASC students: BMEG 2614, PHYS 2054 and DASC 3203. (Typically offered: Irregular)

BMEG 4593. Biomedical Innovations for Global Impact. 3 Hours.
This course focuses on specific problems triggered or exacerbated by selected global health care challenges. Acknowledging the interdependence of our world, where the well-being of one individual is intrinsically connected to the well-being of the entire ecosystem, the course connects participating students with a global and local network of students, faculty, community partners, and mentors, and invite them to develop solutions to some of these health care challenges. Pre- or corequisite: Junior Level Standing. (Typically offered: Fall)
This course is cross-listed with SEVI 4333.

BMEG 460V. Individual Study. 1-6 Hour.
Individual study and research of a topic mutually agreeable to the student and faculty member. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

BMEG 460VH. Honors Individual Study. 1-6 Hour.
Individual study and research of a topic mutually agreeable to the student and faculty member. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.
This course is equivalent to BMEG 460V.

BMEG 4623. Biomedical Transport Phenomena. 3 Hours.
An introduction to the modeling of complex biological systems using principles of transport phenomena and biochemical kinetics. This course will cover molecular transport due to velocity, concentration and thermal gradients. Topics include the conservation relations; rheology of Newtonian and non-Newtonian physiological fluids; regulation of blood flow; steady and transient diffusion in reacting systems; dimensional analysis; transport processes in disease pathology. Prerequisite: BMEG 3653, CHEG 2133 or MEEG 3503, CHEG 2313 or MEEG 2403, and MATH 2584. (Typically offered: Fall)

BMEG 4623H. Honors Biomedical Transport Phenomena. 3 Hours.
An introduction to the modeling of complex biological systems using principles of transport phenomena and biochemical kinetics. This course will cover molecular transport due to velocity, concentration and thermal gradients. Topics include the conservation relations; rheology of Newtonian and non-Newtonian physiological fluids; regulation of blood flow; steady and transient diffusion in reacting systems; dimensional analysis; transport processes in disease pathology. Prerequisite: BMEG 3653, CHEG 2133 or MEEG 3503, CHEG 2313 or MEEG 2403, and MATH 2584. (Typically offered: Fall)
This course is equivalent to BMEG 4623.

BMEG 470V. Special Topics in Biomedical Engineering. 1-4 Hour.
Consideration of current biomedical engineering topics not covered in other courses. Prerequisite: Senior standing. (Typically offered: Irregular) May be repeated for degree credit.

BMEG 4713. Cardiovascular Physiology and Devices. 3 Hours.
Understanding etymology of disease while creating solutions and dedicated devices is the primary focus of biomedical engineering. This course describes an interdisciplinary approach of the clinical and engineering worlds to develop devices for treating cardiovascular disease. The first part of the course will be a thorough review of the relevant anatomic and physiological considerations important for developing devices. Understanding these considerations from an engineering perspective to inform device development will be the second part of the course. Students may not receive credit for both BMEG 4713 and BMEG 5713. Prerequisite: CHEG 2133 or MEEG 3503, and BIOL 2213. (Typically offered: Irregular)

BMEG 4813. Biomedical Engineering Design I. 3 Hours.
This is part one of a two-semester course that introduces students to the basic concepts of design from a biomedical engineering perspective. Groups are organized into teams of 4-5 members. The students put together a development plan and complete an initial prototype. Students will design what is to be fabricated and tested as a medical device or software following design process and product design specification guidelines. Corequisite: Lab component. Pre- or Corequisite: BMEG 4623 and BMEG 2904. (Typically offered: Fall)

BMEG 4823. Biomedical Engineering Design II. 3 Hours.
This is part two of a two-semester course that introduces students to the basic concepts of design from a biomedical engineering perspective. Groups are organized into teams of 4-5 members. The students put together a development plan and complete an initial prototype. Students will design what is to be fabricated and tested as a medical device or software following design process and product design specification guidelines. Corequisite: Lab component. Prerequisite: BMEG 4813. (Typically offered: Spring)

BMEG 4903. Entrepreneurial Bioengineering. 3 Hours.
The course introduces entrepreneurship, business model canvas, and lean start-up principles to the students with a focus on medical device customer discovery and technology commercialization. Degree credit will not be awarded for both BMEG 4903 and BMEG 5903. Prerequisite: The prerequisite for BMEG students is BMEG 2904; prerequisites for DASC students: BMEG 2614 and DASC 2594. (Typically offered: Irregular)

BMEG 4973. Regenerative Medicine. 3 Hours.
This is an advanced course focusing on tissue engineering and regenerative medicine. Topics include stem cell tissue engineering, cell signaling, transport and kinetics, biomaterials and scaffolds, surface interactions, viral and nonviral-based gene delivery, tissue engineered organs, organ transplantation, nanomedicine, cell replacement therapy, and organ regenerative therapy. Technologies used to grow clinical relevant cells and tissues in lab will also be discussed in this course. Pre- or Corequisite: Senior standing. (Typically offered: Irregular)

BMEG 4983. Genome Engineering and Synthetic Biology. 3 Hours.
Genome Engineering and Synthetic Biology examines contemporary topics in genome engineering and synthetic biology and will be taught using a "journal club" - style lecture format. This course covers a broad range of topics in synthetic biology and genome engineering using recently published literature and publicly available data and software and includes an ethics discussion at course end. Prerequisite: BMEG 3653 or DASC 3213. (Typically offered: Fall and Spring)