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 10103 Composition I (ACTS Equivalency = ENGL 1013) (Satisfies General Education Outcome 1.1)	3	
MATH 24004 Calculus I (ACTS Equivalency = MATH 2405) (Satisfies General Education Outcome 2.1)[1]	4	
CHEM 14103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture)	3	
GNEG 11101 Introduction to Engineering I	1	
Select one of the following to satisfy General Education Outcome 4.2:		

HIST 20003 History of the American People to 1877 (ACTS Equivalency = HIST 2113) or HIST 20103 History of the American People, 1877 to Present (ACTS Equivalency = HIST 2123) or PLSC 20003 American National Government (ACTS Equivalency = PLSC 2003)	3	
ENGL 10303 Technical Composition II (ACTS Equivalency = ENGL 1023) (Satisfies General Education Outcome 1.2)		3
Freshman Science Elective with lab[2]		4
MATH 25004 Calculus II		4
PHYS 20304 University Physics I (ACTS Equivalency = PHYS 2034)		4
GNEG 11201 Introduction to Engineering II		1
Year Total:	14	16

Second Year	**Fall**	**Spring**
Sophomore Science Elective with lab[3]	4	
BMEG 26104 Introduction to Biomedical Engineering	4	
MATH 30803 Linear Algebra	3	
Satisfies General Education Outcome 3.4:		
BIOL 10103 Principles of Biology (ACTS Equivalency = BIOL 1014 Lecture) & BIOL 10101 Principles of Biology Laboratory (ACTS Equivalency = BIOL 1014 Lab)	4	
BMEG 28103 Biomechanical Engineering		3
BMEG 29004 Biomedical Instrumentation (with Lab)		4
MATH 25804 Elementary Differential Equations		4
BIOL 25473 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 36304 Biomaterials (with Lab)	4	
BMEG 31204 Biomedical Signals and Systems (with Lab)	4	
CHEG 23103 Thermodynamics of Single-Component Systems or MEEG 24003 Thermodynamics	3	
CHEM 36053 Organic Chemistry I & CHEM 36051 Organic Chemistry I Laboratory	4	
Social Sciences State Minimum Core Elective (Satisfies General Education Outcomes 3.3 and 4.1)[5]	3	
BMEG 36503 Biomedical Modeling and Numerical Methods		3
BMEG 38204 Biomolecular Engineering (with Lab)		4
BMEG 38001 Clinical Observations and Needs Finding		1
CHEG 21303 Fluid Mechanics or MEEG 35003 Mechanics of Fluids		3
BIOL 24103 Human Physiology (ACTS Equivalency = BIOL 2414 Lecture) & BIOL 24101 Human Physiology Laboratory (ACTS Equivalency = BIOL 2414 Lab)		4
STAT 28233 Biostatistics		3
Year Total:	18	18

Fourth Year	**Fall**	**Spring**
BMEG 48103 Biomedical Engineering Design I	3	
BMEG 46203 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 48203 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 24004.

2 The Freshman Science Elective must be chosen from either CHEM 14203/CHEM 14201 or PHYS 20404.

3 The Sophomore Science Elective must be either PHYS 20404 or CHEM 14203/CHEM 14201. (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 10003, ARHS 10003, COMM 10003, DANC 10003, LARC 10003, MUSC 10003, MUSC 100H3, MUSC 10103, MUSC 101H3, MLIT 13303, THTR 1003, THTR 10103, or THTR 101H3.

5 The Social Sciences Elective courses which satisfy General Education Outcomes 3.3 and 4.1 include: ANTH 10203, COMM 10203, HDFS 14003, HDFS 24103, HIST 11193, HIST 11293, HIST 20903, HUMN 111H4, HUMN 211H4, INST 2013, INST 28103, INST 281H3, PLSC 20103, PLSC 28103, PLSC 281H3, RESM 28503, SOCI 10103 , SOCI 201H3, or SOCI 20103.

6 The Social Sciences Elective courses which satisfy General Education Outcome 3.3 include: AGEC 11003, AGEC 21003, ANTH 10203, COMM 10203, ECON 21003, ECON 22003, ECON 21403, EDST 20003, HDFS 14003, HDFS 24103, HDFS 26003, HIST 11193, HIST 111H3, HIST 11293,HIST 112H3, HIST 20003, HIST 20103, HIST 20903, HUMN 111H4, HUMN 112H4, INST 28103, INST 281H3, PLSC 20003, PLSC 20103, PLSC 21003, PLSC 28103, PLSC 281H3, PSYC 20003, RESM 28503, SOCI 10103, SOCI 101H3, or SOCI 20103. 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 10003, CLST 100H3, CLST 10103, HUMN 112H4, PHIL 20003, PHIL 200H3, PHIL 21003.

Biomedical Engineering Technical Electives

BMEG 42103	Tissue Mechanics	3
BMEG 42403	Advanced Biomaterials and Biocompatibility	3
BMEG 44003	Biomedical Microscopy	3
BMEG 44103	Tissue Engineering	3
BMEG 450HV	Honors Thesis	1-4
BMEG 4600V	Individual Study	1-6
BMEG 460HV	Honors Individual Study	1-6
BMEG 49703	Regenerative Medicine	3
BMEG 4700V	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.
Strother, Jim, M.S. (Oklahoma State University), B.S. (University of Arkansas), instructor, 2022.
Wolchok, Jeffrey Collins, Ph.D. (University of Utah), M.S., B.S. (University of California at Davis), Associate Professor, 2011, 2017.
Zhang, Jian, Ph.D. (Carnegie Mellon University), B.S. (Peking University), Assistant Professor, 2022.

Courses

BMEG 26104. 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. Corequisite: Drill component. Prerequisite: (GNEG 132H1, or GNEG 11201, or GNEG 11003, or DASC 10003, or DASC 100H3), CHEM 14103 with a grade of C or better, and MATH 24004. Pre- or corequisite: PHYS 20304. (Typically offered: Fall and Spring)

BMEG 28103. 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 26104, CHEM 14203, and MATH 25004. Pre- or corequisite: PHYS 20404. (Typically offered: Spring and Summer)

BMEG 29004. 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 26104 and MATH 25004. Pre- or corequisite: PHYS 20404. (Typically offered: Spring)

BMEG 31204. 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 29004. (Typically offered: Fall)

BMEG 36304. 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 28103, CHEM 14203, and BIOL 10103 and BIOL 10101. (Typically offered: Fall)

BMEG 36503. 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 25804. Prerequisite: BMEG 26104, and (MATH 26004 or MATH 30803). (Typically offered: Spring)

BMEG 365H3. 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 25804. Prerequisite: BMEG 26104, and (MATH 26004 or MATH 30803). (Typically offered: Spring)

BMEG 38001. 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 28103 or BMEG 29004; prerequisites for DASC students: BMEG 26104 and DASC 25904. (Typically offered: Fall and Spring)

BMEG 38204. 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: CHEM 14203. Pre- or corequisite: BMEG 36304 and BIOL 25473. (Typically offered: Spring)

BMEG 382H4. 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 36304, CHEM 14203, and BIOL 25473. (Typically offered: Spring)

BMEG 39103. 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 25804, PHYS 20404, and BMEG 26104. (Typically offered: Fall)

BMEG 42103. 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 42103 and BMEG 52103. Prerequisite: BMEG 28103, BMEG major and Senior standing. (Typically offered: Irregular)

BMEG 42403. 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 46203. Prerequisite: BMEG 36304. (Typically offered: Irregular)

BMEG 42503. 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 44003. 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 29004, PHYS 20404, BMEG major and Senior standing; prerequisites for DASC students: BMEG 26104, PHYS 20304 and DASC 21103. (Typically offered: Irregular)

BMEG 44103. 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 38204 and BIOL 25473. (Typically offered: Irregular)

BMEG 450HV. 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 45103. 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 45103 and BMEG 55103. Prerequisite: The prerequisites for BMEG students are BMEG 29004 and senior standing; prerequisites for DASC students: BMEG 26104, PHYS 20304 and DASC 21103 and senior standing. (Typically offered: Irregular)

BMEG 45203. 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 45203 and BMEG 55203. Prerequisite: The prerequisites for BMEG students are BMEG 31204 and BMEG 36503; prerequisites for DASC students: BMEG 26104, PHYS 20304 and DASC 32003. (Typically offered: Irregular)

BMEG 45903. 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)

BMEG 4600V. 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 460HV. 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 4600V.

BMEG 46203. 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 39103, CHEG 21303 or MEEG 35003) and (CHEG 23103 or MEEG 24003). (Typically offered: Fall)

BMEG 462H3. 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 36503, CHEG 21303 or MEEG 35003, CHEG 23103 or MEEG 24003, and MATH 25804. (Typically offered: Fall)

BMEG 4700V. 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 47103. 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 47103 and BMEG 57103. Prerequisite: BIOL 24103 and (BMEG 39103 or CHEG 21303 or MEEG 35003). (Typically offered: Irregular)

BMEG 48103. 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: BMEG 46203 and lab component. Prerequisite: BMEG 38001. Pre- or corequisite: STAT 28233 or MATH 21003. (Typically offered: Fall)

BMEG 48203. 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 48103. (Typically offered: Spring)

BMEG 49003. 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 49003 and BMEG 59003. Prerequisite: The prerequisite for BMEG students is BMEG 29004; prerequisites for DASC students: BMEG 26104 and DASC 25904. (Typically offered: Irregular)

BMEG 49703. 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 49803. 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 36503 or DASC 32103. (Typically offered: Fall and Spring)