Biomedical Engineering (BMEG)

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)
This course is equivalent to BMEG 36503.

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)
This course is equivalent to BMEG 38204.

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)
This course is cross-listed with SEVI 43303.

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)
This course is equivalent to BMEG 46203.

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)

BMEG 51003. Design and Analysis of Experiments in Biomedical Research. 3 Hours.
An advanced course covering sample size estimation with power calculations, protection of vertebrate animals and human subjects, factorial design, multivariate analysis of variance, parametric and non-parametrics data analysis, Kaplan-meier analysis, and post-test correction of multiple comparisons as related to biomedical data. Prerequisite: MATH 25804 and BMEG 36503 or equivalents. (Typically offered: Irregular)

BMEG 52103. 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 and BMEG 46203 or equivalents. (Typically offered: Irregular)

BMEG 52203. Genome Engineering and Synthetic Biology. 3 Hours.
Genome Engineering and Synthetic Biology provides an overview of contemporary topics in genome engineering and synthetic biology. This course will introduce a range of topics in synthetic biology and genome engineering using recently published literature and publicly available data sets and software. In this rapidly evolving field, an ethics discussion will be held at the end of the course on potential topics including human embryo editing, genomic data privacy, patent claims, and GMOs. Students may not receive credit for both BMEG 49803 and BMEG 52203. Prerequisite: Graduate student standing. (Typically offered: Spring)

BMEG 52503. 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. Students may not receive credit for both BMEG 42503 and BMEG 52503. (Typically offered: Irregular)

BMEG 53103. 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. Prerequisite: BMEG 36304 and BMEG 46203 or equivalents. (Typically offered: Irregular)

BMEG 54103. 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. Students may not earn credit for both BMEG 54103 and BMEG 44103. Prerequisite: Graduate Standing. (Typically offered: Irregular)

BMEG 54203. Regenerative Medicine. 3 Hours.
The course covers five broad areas: Biological and molecular basis for regenerative medicine, tissue development, regenerative medicine and innovative technologies, clinical applications of regenerative medicine, and regulation and ethics. Prerequisite: BIOL 25473 and BMEG 38204 or equivalents. (Typically offered: Irregular)

BMEG 55103. 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. (Typically offered: Irregular)

BMEG 55203. 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: Graduate standing. (Typically offered: Irregular)

BMEG 5600V. Advanced Individual Study. 1-6 Hour.
Individual study and research of a topic mutually agreeable to the student and faculty member. Prerequisite: Graduate standing. (Typically offered: Irregular)

BMEG 5700V. Advanced Special Topics. 1-6 Hour.
Consideration of current biomedical engineering topics not covered in other courses. Prerequisite: Graduate standing. (Typically offered: Irregular) May be repeated for up to 15 hours of degree credit.

BMEG 57103. 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: Graduate standing. (Typically offered: Irregular)

BMEG 58000. Graduate Seminar I. 0 Hours.
A weekly seminar series comprised of presentations by invited speakers and graduate students as well as didactic instruction in relevant topics including research ethics, authorship, biosafety and the use of animals in biomedical research. Prerequisite: BMEG 58001. (Typically offered: Fall) May be repeated for up to 0 hours of degree credit.

BMEG 58001. Graduate Seminar I. 1 Hour.
A weekly seminar series comprised of presentations by invited speakers and graduate students as well as didactic instruction in relevant topics including research ethics, authorship, biosafety and the use of animals in biomedical research. (Typically offered: Fall) May be repeated for up to 2 hours of degree credit.

BMEG 58100. Graduate Seminar II. 0 Hours.
A weekly seminar series comprised of presentations by invited speakers and graduate students as well as didactic instruction in relevant topics including professional development, career options, effective communication, technology transfer, clinical translation and intellectual property. Prerequisite: BMEG 58101. (Typically offered: Spring) May be repeated for up to 0 hours of degree credit.

BMEG 58101. Graduate Seminar II. 1 Hour.
A weekly seminar series comprised of presentations by invited speakers and graduate students as well as didactic instruction in relevant topics including professional development, career options, effective communication, technology transfer, clinical translation and intellectual property. (Typically offered: Spring) May be repeated for up to 2 hours of degree credit.

BMEG 59003. 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. Graduate degree credit will not be awarded for BMEG 49003. Degree credit will not be awarded for both BMEG 49003 and BMEG 59003. (Typically offered: Irregular)

BMEG 59503. Fundamentals of Fracture and Fatigue in Structures. 3 Hours.
The course will cover the concepts of linear-elastic, elastic-plastic and time-dependent Fracture Mechanics as applied to fracture in a variety of materials, structures, and operating conditions. The examples will include fracture in large components such as aircraft, bridges and pressure vessels and also in bones and in soft materials and human tissue. Prerequisite: Graduate standing in Civil, Mechanical or Biomedical Engineering or consent of the instructor. (Typically offered: Fall and Spring)
This course is cross-listed with MEEG 59503, CVEG 59503.

BMEG 6000V. Master's Thesis. 1-6 Hour.
Master's Thesis. Prerequisite: Graduate standing. (Typically offered: Irregular) May be repeated for degree credit.

BMEG 7000V. Doctoral Dissertation. 1-6 Hour.
Doctoral Dissertation. Prerequisite: Graduate standing. (Typically offered: Irregular) May be repeated for degree credit.