

BIOENGINEERING (BENG)

100 Level Courses

BENG 101: *Introduction to Bioengineering*. 3 credits.

Surveys the field of bioengineering and the global impact of technology innovation in solving problems in biology and medicine with an emphasis on engineering tools and concepts. Introduces mathematical modeling and analysis of bioengineering problems through the use of standard software packages for simulation. Other topics include: prototyping and design, ethics and regulatory affairs, and history and career paths in Bioengineering. Offered by Bioengineering. Limited to two attempts.

Registration Restrictions:

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture, Recitation

200 Level Courses

BENG 220: *Physical Bases of Biomedical Systems*. 3 credits.

Introduces the physical basis of biomedical systems and signals. Demonstrates basic concepts of systems and signals theory, and shows their derivation from the biophysical concepts such as mechanics, fluid mechanics, pharmacokinetics and molecular biophysics which underlie the signals in living systems. Aims at providing the student with the mathematical and physical understanding to quantitatively describe biological systems. Offered by Bioengineering. Limited to two attempts. Equivalent to ECE 220.

Registration Restrictions:

Required Prerequisites: (BENG 101^C, MATH 203^C and PHYS 160^C) and (MATH 214^C or 216^C).

* May be taken concurrently.

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture, Recitation

300 Level Courses

BENG 301: *Bioengineering Measurements*. 3 credits.

Introduces the basic concepts and tools for making biomedical measurements, describes instrumentation design and analysis considerations, and discusses several practical applications. Offered by Bioengineering. Limited to two attempts.

Registration Restrictions:

Required Prerequisites: BENG 380^C, 320^C and 313^C.

^C Requires minimum grade of C.

Enrollment is limited to students with a major, minor, or concentration in Bioengineering.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 302: *Bioengineering Measurements Lab*. 1 credit.

Provides hands-on experience with sensors and instrumentation relevant to the analysis of living systems and related processes. Biomedical measurements include electrocardiograms, electromyograms, spirometry, pulse oximetry, and glucose monitoring. Offered by Bioengineering. Limited to two attempts.

Registration Restrictions:

Required Prerequisite: BENG 301^{*C}.

* May be taken concurrently.

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Laboratory

BENG 304: *Modeling and Control of Physiological Systems*. 3 credits.

Introduces a systems-level understanding of biomedical systems. Emphasis on mathematical modeling of dynamic systems, including the role of feedback. Analogies between electrical and mechanical systems will be discussed. Examples covered will include multiple scales ranging from cells to organ systems. Offered by Bioengineering. Limited to two attempts.

Specialized Designation: Writing Intensive in the Major

Registration Restrictions:

Required Prerequisites: MATH 214^C and PHYS 260^C and (BENG 320^C or SYST 320^C) and BENG 313^C.

^C Requires minimum grade of C.

Enrollment is limited to students with a major, minor, or concentration in Bioengineering.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 313: *Physiology for Engineers*. 3 credits.

Provides a broad introduction to the subject of human physiology, focusing on learning the subject matter from an engineering viewpoint. Emphasis on organs and physiological systems where engineering has a significant role. Offered by Bioengineering. Limited to two attempts.

Registration Restrictions:

Required Prerequisites: (BENG 101^C) and (MATH 114^{B-} or 116^{B-}) and (BIOL 213^C).

^C Requires minimum grade of C.

^{B-} Requires minimum grade of B-.

Enrollment is limited to students with a major, minor, or concentration in Bioengineering.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 320: *Bioengineering Signals and Systems*. 3 credits.

Introduces the conversion of analog signals to digital ones and methods for using digitally processed signals in biomedical applications. Offered by Bioengineering. Limited to two attempts. Equivalent to ECE 320.

Registration Restrictions:

Required Prerequisites: BENG 101^C, 220^C and MATH 214^{B-}.

^C Requires minimum grade of C.

^{B-} Requires minimum grade of B-.

Enrollment is limited to students with a major, minor, or concentration in Bioengineering.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture, Recitation

BENG 322: Health Data Challenges. 3 credits.

Covers methodology and tools used to work with health data structures supporting organizations' needs for reliable data that are captured, stored, processed, integrated, and prepared for further querying, decision making, data mining and knowledge discovery for a variety of clinical and organizational purposes. Data security and privacy, data standards, data interoperability, health information exchange, and big data analytics are discussed. Offered by Bioengineering. Limited to two attempts. Equivalent to IT 322.

Registration Restrictions:

Required Prerequisites: IT 214^C and (STAT 250^C or 344^C).

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 341: Introduction to Biomaterials. 3 credits.

To provide a fundamental understanding of current, state of the art, and future directions of biomaterials. Offered by Bioengineering. Limited to two attempts.

Specialized Designation: Scholarly Inquiry

Registration Restrictions:

Required Prerequisites: (CHEM 251^C or 211^C) and (MATH 113^C) and (BIOL 213^C).

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 380: Introduction to Circuits and Electronics. 3 credits.

Builds on simple circuit concepts introduced in PHYS 260. Includes circuit analysis using superposition, equivalent circuits and transient analysis of RL, RC and RLC circuits; sinusoidal excitations, AC steady state analysis; frequency response; operational amplifiers; semiconductor devices such as diodes, field effect and bipolar transistors; and digital logic circuits. (Not intended for those majoring in electrical or computer engineering.) Offered by Bioengineering. Limited to two attempts.

Registration Restrictions:

Required Prerequisites: (PHYS 260^C and MATH 214^B) and BENG 320^{*C}.

* May be taken concurrently.

^C Requires minimum grade of C.

^B Requires minimum grade of B-.

Enrollment is limited to students with a major, minor, or concentration in Bioengineering.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture, Recitation

BENG 381: Circuits and Electronics Lab. 1 credit.

Lab associated with BENG 380. Provides laboratory experience in basic electronics emphasizing issues and considerations that are paramount for biomedical instrumentation. Not intended for those majoring in electrical or computer engineering. Notes: Not intended for those

majoring in electrical or computer engineering. Offered by Bioengineering. Limited to two attempts.

Registration Restrictions:

Required Prerequisites: PHYS 261^C and BENG 380^{*C}.

* May be taken concurrently.

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Laboratory

BENG 390: Engineering Design and Fabrication. 3 credits.

Project based course where students will design projects containing analog and digital components as well as mechanical parts. Students will simulate, build, and test their projects. Offered by Bioengineering. Limited to two attempts. Equivalent to ECE 390.

Registration Restrictions:

Required Prerequisites: (BENG 380^C, ECE 280^C or 285^C).

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 392: Engineering Design Studio. 1 credit.

Identification and feasibility study of advance engineering problems. Application of path, physics and engineering methods to challenging projects. Preliminary design, modeling, simulation and prototyping of projects. Notes: This course should be taken preceding ECE/BENG 492. Offered by Bioengineering. May be repeated within the degree for a maximum 2 credits. Equivalent to ECE 392.

Recommended Prerequisite: 75 hours of completed coursework applicable to EE, CpE, or BIOE degree and permission of instructor.

Registration Restrictions:

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 395: RS: Mentored Research in Bioengineering. 1-3 credits.

Introduces the scientific research process through "hands on" experience: students are matched with faculty mentors who are actively involved in Bioengineering-related research. Requires no less than 60 hours per semester working with mentors. Offered by Bioengineering. May be repeated within the degree for a maximum 6 credits.

Specialized Designation: Research/Scholarship Intensive

Recommended Prerequisite: At least 60 credit hours applicable to the Bioengineering program.

Registration Restrictions:

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Independent Study

400 Level Courses

BENG 406: Introduction to Biomechanics. 3 credits.

This course introduces the fundamental principles of musculoskeletal biomechanics, computational simulation of movement, and OpenSim simulator. Topics include functions and models of the musculoskeletal structures, mathematical description of motion, kinetics, and simulation

of movement using OpenSim. Offered by Bioengineering. Limited to two attempts.

Registration Restrictions:

Required Prerequisites: (PHYS 160^C or 243^C) and MATH 203^C and 214^C and (BENG 220^C, SYST 220^C or ECE 220^C) and BENG 313^C.

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 420: Bioinformatics for Engineers. 3 credits.

This course introduces the fundamental techniques and tools for analyzing biomedical data, important for many biomedical engineering problems. Topics include regression, classification, clustering, dimensionality reduction, data representation, pattern matching and algorithm performance evaluation. This innovative course will leverage hybrid learning through a combination of lectures, on-line content, and individual and group projects involving hands-on analysis. Offered by Bioengineering. Limited to two attempts.

Registration Restrictions:

Required Prerequisites: BENG 320^C, SYST 320^C or ECE 320^C.

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 421: Introduction to Tissue Engineering. 3 credits.

Designed to provide exposure to the concepts of cell/tissue functions and behavior and strategies to manipulate their responses, biomaterials to construct scaffolds, modern techniques of artificial organ development and wound healing and most importantly, the utilization of engineering principles for biomedical applications. Offered by Bioengineering. May not be repeated for credit.

Recommended Prerequisite: BENG 220.

Registration Restrictions:

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 437: Medical Image Processing. 3 credits.

Covers the basic concepts of image processing in the context of medical applications. It focuses on the basics of image enhancement in the spatial domain, image enhancement in the frequency domain, image restoration, morphological image processing, image registration and segmentation feature extraction and classification. Offered by Bioengineering. Limited to two attempts.

Recommended Prerequisite: BENG 320.

Registration Restrictions:

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 441: Nanotechnology in Health. 3 credits.

Introduces fundamental principles of a wide range of nanoscale biomaterials and their applications in medicine and engineering. Offered by Bioengineering. Limited to two attempts.

Registration Restrictions:

Required Prerequisites: (BIOL 213^C and PHYS 160^C) and (CHEM 251^C or 211^C).

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 451: Translation and Entrepreneurship in Bioengineering. 3 credits.

This course focuses on teaching the process of translational research and on creating both a medical device and a company vision. Emphasis is made on creating a robust medical device prototype based on a deep understanding of the disease. Regulatory and reimbursement processes are also addressed in detail. This course will draw upon lectures and different guest speakers. Offered by Bioengineering. Limited to two attempts.

Registration Restrictions:

Required Prerequisites: (BIOL 213^C) and (CHEM 251^C or 211^C).

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 491: Bioengineering Senior Seminar I. 1 credit.

Covers the variety of responsibilities of bioengineers to society. Topics include ethics, regulation, research, industry, entrepreneurship, and cost issues. Professional approaches to job searching and effective technical communication will also be discussed. Speakers include faculty, invited guests from industry and government, as well as students. Notes: Students cannot receive credit for BENG 491 and ECE 491. Offered by Bioengineering. Limited to two attempts. Equivalent to ECE 491.

Registration Restrictions:

Enrollment limited to students with a class of Senior Plus or Senior.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Seminar

BENG 492: Senior Advanced Design Project I. 2 credits.

Conception of senior design project in bioengineering and determination of feasibility of proposed project. Work includes developing preliminary design and implementation plan. Notes: Students cannot receive credit for both BENG 492 and ECE 492. Offered by Bioengineering. Limited to two attempts.

Mason Core: Capstone, Synthesis

Specialized Designation: Research Associated

Recommended Prerequisite: 90 credit hours applicable to the Bioengineering Program.

Registration Restrictions:

Required Prerequisites: (COMM 100^C or 101^C) and ENGH 302^C.

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 493: RS: Senior Advanced Design Project II. 2 credits.

Implementation of project for which preliminary work was done in BENG 492. Project includes designing and constructing hardware, writing required software, conducting experiments or studies, and testing

complete system. Requires oral and written reports during project and at completion. Notes: Implementation of project for which preliminary work was done in BENG 492. Offered by Bioengineering. Limited to two attempts.

Mason Core: Capstone, Synthesis

Specialized Designation: Research/Scholarship Intensive

Registration Restrictions:

Required Prerequisite: BENG 492^C.

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

BENG 495: *Bioengineering Senior Seminar II*. 1 credit.

Covers a variety of responsibilities of bioengineers. Topics include dealing with biomedical ethics, regulatory requirements, global considerations, and health care costs. Speakers will include faculty as well as guests from industry, government, and academia. Students are required to explore and then present some material themselves. Offered by Bioengineering. Limited to two attempts.

Specialized Designation: Writing Intensive in the Major

Recommended Prerequisite: 90 credit hours applicable to the Bioengineering Program.

Registration Restrictions:

Required Prerequisite: COMM 100^C.

^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Seminar

BENG 499: *Special Topics in Bioengineering*. 0-4 credits.

Topics of special interest to undergraduates. Notes: May be repeated if topics substantially differ. Offered by Bioengineering. May be repeated within the term for a maximum 11 credits.

Registration Restrictions:

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

500 Level Courses

BENG 501: *Bioengineering Research Methods*. 3 credits.

Examines approaches for scientific research with emphasis on bioengineering. Topics include biophysical origins of bioengineering measures, tools and technology for bioengineering data collection, basic principles of experimental design and statistical analyses, and interpretation of scientific results. Special attention will be given to ethical issues associated with the collection, use, and dissemination of data. Offered by Bioengineering. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

BENG 525: *Neural Engineering*. 3 credits.

Provides an overview of topics in Neural Engineering. Topics covered range from sensory and motor prosthetic devices, stimulation of biological tissue, bioelectrodes and characterization techniques, brain-machine interfaces, and engineered devices to ameliorate neurodisorders. Prior knowledge in electrical or computer engineering disciplines required. Offered by Bioengineering. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

BENG 537: *Introduction to Medical Image Processing*. 3 credits.

Topics include overview of medical imaging systems, image representation and formats, basic filtering operations, feature detection, and introduction to image segmentation. Projects will focus on biomedical image applications. Offered by Bioengineering. May not be repeated for credit.

Recommended Prerequisite: BENG 320 or permission of instructor.

Schedule Type: Lecture

BENG 538: *Medical Imaging*. 3 credits.

Introduction to the physical, mathematical and engineering foundations of modern medical imaging systems, medical image processing and analysis methods. Introduces engineering students to clinical applications of medical imaging. Emphasis on diagnostic ultrasound and magnetic resonance imaging methods; several other modalities are also covered. Provides overview of recent developments and future trends in the field of medical imaging, discusses some of the challenges and controversies, and involves hands-on experience applying the methods learnt in class to real-world problems. Offered by Bioengineering. May not be repeated for credit. Equivalent to ECE 538.

Recommended Prerequisite: ECE 320 or equivalent; PHYS 262 or equivalent.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture**BENG 541: Biomaterials.** 3 credits.

Covers the principles of biomaterials and biological interactions with materials, including an overview of biomaterials characterization, design and testing. Specific topics include the use of polymers, ceramics and metallics in biomaterials, drug delivery applications, tissue engineering from an orthopedic and vascular perspective, biocompatibility, acute and chronic biological response to implanted material, and in vitro and in vivo testing of biomaterials. Offered by Bioengineering. May not be repeated for credit.

Recommended Prerequisite: BIOL 213 (or equivalent), CHEM 251 (or equivalent).

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture**BENG 550: Advanced Biomechanics.** 3 credits.

Introduces the fundamental concepts of musculoskeletal biomechanics, and how to apply mechanical principles to quantitatively describe and analyze movement. Topics include properties, functions, and models of the musculoskeletal structures, 3D kinematics, locomotion, and instrumentation systems applied in musculoskeletal biomechanics and movement analysis. Offered by Bioengineering. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture**BENG 551: Translational Bioengineering.** 3 credits.

Demonstrates the process for the creation of both medical device prototypes and medical device companies. Focuses on designing and building a robust medical device prototype and writing a business plan. Also addresses cost of healthcare, reimbursement, regulatory processes, intellectual property, and marketing and sales aspects. Course will feature lectures, videos, and guest speakers who are successful medical device entrepreneurs. Offered by Bioengineering. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture**BENG 590: Selected Topics in Bioengineering.** 3 credits.

Addresses selected topics from recent developments in various Bioengineering disciplines. Content may vary each semester depending on instructor and students' interests. Offered by Bioengineering. May be repeated within the term for a maximum 6 credits.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture**600 Level Courses****BENG 636: Advanced Biomedical Signal Processing.** 3 credits.

Provides an overview of advanced topics in biomedical signal processing with an emphasis on practical applications. Topics include introduction to physiological origins of biomedical signals, stochastic and adaptive signal processing, spectral estimation, signal modeling and analysis of nonstationary signals. Offered by Bioengineering. May not be repeated for credit.

Recommended Prerequisite: ECE 535 or equivalent; ECE 528 or equivalent.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture**BENG 641: Advanced Nanotechnology in Health.** 3 credits.

Presents interdisciplinary scientific and engineering approaches to solve relevant medical problems. Contents include polymer structure, composition, and material properties, natural and synthetic polymers, and their application to design novel nanocarriers for controlled drug release, scaffolds for tissue engineering, and new vectors for vaccines. The relevance of nanotechnology to advance treatments for cancer, infectious and neurodegenerative diseases are discussed in depth. Offered by Bioengineering. May not be repeated for credit.

Recommended Prerequisite: BENG 541, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

BENG 699: *Advanced Topics in Bioengineering.* 3 credits.

Advanced topics of current interest in bioengineering. Topics chosen so they do not duplicate other courses in department. Active participation encouraged in form of writing and presenting papers in research areas. Offered by Bioengineering. May be repeated within the degree for a maximum 6 credits.

Recommended Prerequisite: Permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

700 Level Courses

BENG 725: *Computational Motor Control.* 3 credits.

Uses approaches from robotics, control theory, and neuroscience to understand biological motor systems. Contents include modeling muscles, reflexes and neural systems to understand how the central nervous system plans and controls movement of the eyes and limbs. The theoretical control problem is compared to known neuronal properties of the motor system and diseases of the motor system affecting movement control. Offered by Bioengineering. May not be repeated for credit.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

BENG 738: *Advanced Medical Image Processing.* 3 credits.

Advanced Medical Image Processing covers advanced processing techniques used in modern medical imaging. The course aims at developing an understanding of the mathematical background, principles and application of techniques such as segmentation, registration, morphometry, general linear modeling, principal and independent component analysis. Offered by Bioengineering. May not be repeated for credit.

Recommended Prerequisite: BENG 320 (or equivalent), ECE 537 (or equivalent).

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

BENG 745: *Biomedical Systems and Microdevices.* 3 credits.

Bio-micro-electro-mechanical systems (BioMEMS) provide a robust approach to mimic in vivo microenvironments within controlled in vitro settings. This course introduces students to the highly interdisciplinary field of Lab-on-a-Chip technologies with emphasis on its advanced applications in biological and biomedical engineering. In addition to the microfabrication processes, a variety of analytical techniques routinely used in biomedical research will also be covered. Offered by Bioengineering. May not be repeated for credit.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

BENG 750: *Modeling and Simulation of Human Movement.* 3 credits.

Introduces the development and simulation of data-driven 3D neuro-musculoskeletal models to quantitatively study human movement in health and disease. Topics include reconstructing 3D models from imaging data, estimating kinematics from motion data, simulating movement incorporating multimodality data, and analyzing muscle and joint forces. Students use computational biomechanics software. The course consists of lectures, article presentations, modeling assignments and a project. Offered by Bioengineering. May not be repeated for credit.

Recommended Prerequisite: BENG 550 or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

BENG 798: *Independent Reading and Research in Bioengineering.* 1-6 credits.

Independent study in Bioengineering under the supervision of a faculty member, resulting in an acceptable technical report or presentation. This course may be repeated once for a total of 12 credit hours towards a graduate degree in Bioengineering. Offered by Bioengineering. May be repeated within the degree for a maximum 12 credits.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Thesis

800 Level Courses

BENG 800: *Bioengineering Colloquium*. 0 credits.

Students are required to attend colloquia including talks by distinguished speakers, faculty candidates, and Mason faculty. Notes: Required attendance and participation in a minimum of 3 seminars per semester. Offered by Bioengineering. May be repeated within the degree.

Recommended Prerequisite: Admission to PhD Bioengineering program.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Seminar

BENG 820: *Seminar in Neuroengineering*. 3 credits.

Selective analysis and discussion of topics in neuroengineering in areas of current research interest. Topics may include brain machine interfaces, advanced materials for implantable devices, computational neuroscience, neuronal biosensors and assays, and neuroprosthetics. Offered by Bioengineering. May be repeated within the degree for a maximum 6 credits.

Recommended Prerequisite: Admission to PhD Bioengineering program or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Seminar

BENG 830: *Seminar in Biomedical Imaging*. 3 credits.

Selective analysis and discussion of topics in biomedical imaging in areas of current research interest. Topics may include techniques and analyses for ultrasound, magnetic resonance imaging (MRI), functional MRI, nuclear imaging, computer assisted tomography, positron emission tomography, and emergent approaches to imaging for health and disease. Offered by Bioengineering. May be repeated within the degree for a maximum 6 credits.

Recommended Prerequisite: Admission to PhD Bioengineering program or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Seminar

BENG 840: *Seminar in Nano-scale Bioengineering*. 3 credits.

Selective analysis and discussion of topics in nano-scale bioengineering in areas of current research interest. Topics may include nanoengineered

materials, nanoscale devices and systems, and novel nano-scale fabrication and modeling approaches with application to biomedicine. Offered by Bioengineering. May be repeated within the degree for a maximum 6 credits.

Recommended Prerequisite: Admission to PhD Bioengineering program or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Seminar

BENG 850: *Seminar in Biomechanics*. 3 credits.

Selective analysis and discussion of topics in biomechanics in areas of current research interest. Topics may include computational and physiological modeling for biomechanics, multiscale representation of biomechanical systems, data fusion techniques for biomechanics, and application of quantitative biomechanics for diagnostics or medical intervention. Offered by Bioengineering. May be repeated within the degree for a maximum 6 credits.

Recommended Prerequisite: Admission to PhD Bioengineering program or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Seminar

900 Level Courses

BENG 998: *Doctoral Dissertation Proposal*. 1-12 credits.

Work on research proposal that forms basis for doctoral dissertation. May be repeated as needed. Notes: No more than 24 credits of BENG 998 and 999 may be applied to doctoral degree requirements. Offered by Bioengineering. May be repeated within the degree for a maximum 12 credits.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Dissertation

BENG 999: *Doctoral Dissertation*. 1-12 credits.

Formal record of commitment to doctoral dissertation research under direction of faculty member in bioengineering. May be repeated as needed. Notes: Once enrolled in 999, students must maintain continuous registration in 999 each semester until graduation, excluding summers. Students who defend in the summer must be registered for at least 1 credit of 999 in the summer Offered by Bioengineering. May be repeated within the degree for a maximum 12 credits.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy.

Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Dissertation