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The School of Biomedical Engineering, Science and Health Systems 2008-2009 Graduate Course Descriptions

Biomedical Engineering & Science Courses

BMES 501 Medical Sciences I

First course in a three-course sequence designed to acquaint students with the fundamentals of biology and physiology from an engineering perspective. This first course covers evolution, genetics, molecular biology and basic cellular physiology.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 502 Medical Sciences II

Second course in a three-course sequence designed to acquaint students with the fundamentals of biology and physiology from an engineering perspective. This second course covers tissues, muscle and nerve function, cardiovascular systems and respiration.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 503 Medical Sciences III

Third course in a three-course sequence designed to acquaint students with the fundamentals of biology and physiology from an engineering perspective. This third course covers renal and digestive systems.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 504 Medical Sciences IV

Mechanical, physical, electrical, and mathematical models of living systems, including feedback control systems. The laboratory part includes computer simulation so that data obtained from laboratory experiments may be compared with those predicted.

Credits: 0.00 to 4.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 505 Math for Biomed Sciences I

This course is for students of biology and related medical fields aimed at bridging the gap between qualitative and quantitative approaches in the study of biological processes. Topics include single and multivariable calculus infinite series, etc.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 506 Math for Biomed Sci II

This course for students of biomedical science or biomedical engineering is designed to permit the student to go on to advanced

studies in engineering and science in which differential equations are needed. Biological applications are emphasized.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 507 Math for Biomed Sci III

This course covers topics in Fourier series and orthogonal functions, partial differential equations, and boundary value problems. Applications are made to problems in neuro-physiology, cellular transport, and biological oscillations.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 508 Cardiovascular Engineering

This course emphasizes engineering approaches to the analysis of the cardiovascular system focusing on fundamental mechanics and emerging technologies.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 509 Entrepreneurship for BMES

This course serves as the foundation course in entrepreneurship and is designed to provide students with a complete working knowledge of the modern entrepreneurial and business planning process.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 510 Biomedical Statistics

This course introduces the graduate student to the fundamentals of inferential statistics with biomedical applications. It covers topics in data presentation, sampling, experimental design, probability and probability distributions.

Credits: 4.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 511 Prin Sys Anl App Biomed I

Covers formulation of biological problems by rigorous mathematical techniques, including application of conservation laws, network theorems, and mesh and nodal analysis.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 512 Princ Sys Analy Biomed II

Continues BMES 511. Emphasizes input/output transfer function problems, linear systems and linear operations, and impulse response. Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 513 Biomedical Electronics

Physical principles in the operation of both integrated circuits and discrete components. Analysis and design of transducers, amplifiers, oscillators, logic circuits, etc., with particular application to biomedical problems. (BMS)

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 514 Comp Appl Biomed Research

This course is intended to familiarize students with at least one computer language and to demonstrate computer applications in diagnosis, monitoring, and biomedical signal processing. (BMS)

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 515 Exp Design in Biomed Research

This course is designed to introduce students to the fundamental principles of experimental design and statistical analysis as applied to biomedical research with animals and humans. Topics to be covered include experimental design and clinical design.

Credits: 0.00 to 4.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 521 Principles of Bioengineering

Principles of transduction and measurement, including characterization of the measurements systems, and invasive vs. noninvasive methods. (BME)

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 522 Princ Bioeng II

In-depth analysis of selected electromechanical transducer principles; review of important transduction methods in bioengineering; biopotential electrodes and chemical electrodes. (BME)

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 523 Princ Bioengr III

Microprocessor applications in biomedical engineering, including interfacing, data processing, display, and storage. (BME)

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 524 Introduction to Biosensors

An introductory course in the general area of microsensors covering basic sensing mechanisms and various types of conductometric, acoustic, silicon, optical and MEMS microsensors. Two case studies involving biosensors and acoustics sensors are explored.

Credits: 0.00 to 4.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 525 Advanced Biosensors

The second course in a two-course sequence, this course covers aspects of modern biosensor design methods and addresses challenges associated with fabrication technologies and instrumentation techniques. Topics covered include the theory and modeling of

Credits: 0.00 to 4.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 531 Human Chronbiol and Sleep I

This course advances the student's knowledge of biological time-keeping and adaptive functions of biological clocks. It includes such topics as biochemical and physiological models of biological blocks, adjustment to environmental cycles and rhythms in be

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 532 Human Chronbiol and Sleep II

This course continues BMES 531. It covers topics in the patterns, rhythms, evolution, neurology, psychology and overall functions of sleep.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 538 Biomedical Ethics and Law Introduces a wide spectrum of ethical, regulatory, and legal issues facing health care practitioners and biomedical researchers. The course helps students become aware of the ethical and legal issues involved in their work while increasing the student's

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 543 Quantitative Systems Biology

This course uses a systems engineering approach to provide a foundation in systems biology and pathology informatics. Topics covered include the robust complex network of genes and proteins; cell as basic units of life; communication of cells with other c

Credits: 0.00 to 4.50

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 544 Genome Information Engineering

This course is designed to provide students with hands-on experience in the application of genomic, proteomic, and other large-scale information to biomedical engineering. The underlying goal is to develop an understanding of highthrough experimental tec

Credits: 0.00 to 4.50

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 545 Biosystems Modeling

This course provides hands-on experience in advanced computational methods used in systems biology: pathway and circuitry, feedback and control, cellular automata, sets of partial differential equations, stochastic analysis, and biostatistics.

Credits: 0.00 to 4.50

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 546 Biocomputational Languages

This course provides hands-on education in C/C++, MATLAB, Java, and Perl languages used in biomedical applications. The principle application areas to be investigated include image analysis, and feedback and control systems.

Credits: 0.00 to 4.50

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 551 Biomedical Signal Processing

Introduces discrete time signals and systems; origin and classification of biomedical signals; data acquisition, filtering, and spectral estimation of medical signals; compression of medical signals; and new processing approaches.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 552 Intro to Bioacoustics

This course covers essential materials for anyone who is interested in the application of acoustical waves in biomedical and material science. The main objective is to familiarize students with the propagation of acoustic waves in different media.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 561 Intro Sys Anlysis BMES

This course acquaints students with the methods of dynamical systems analysis as used to understand biological phenomena. Uses mathematical/engineering models from several areas of biological/medical research to describe the function of systems.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 563 Robotics in Medicine I

This course provides an introduction to the use of haptics (the use of somtaosensory information) in the design of robotic devices in surgery. Topics covered include actuators, sensors, nonportable feedback and portable force feedback.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 565 Robotics in Medicine II

This course covers the use of robots in surgery and included aspects of safety, robot kinematics, analysis of surgical performance using robotic devices, inverse kinematics, velocity analysis and acceleration analysis.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 566 Robotics in Medicine III

This course covers topics in the design of medical robotic systems, including force and movement analysis for robotic arms, dynamics, computer vision and vision-based control. Thus use of haptics, vision systems and robot dynamics are examined.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 571 Applied Evolution

This course is designed to provide students with an evolutionary perspective on health and disease. The focus is on humans as products of evolution by natural selection.

Credits: 4.00

College: School of Biomedical Engineering, Science & Health Systems
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BMES 601 Anatomy I

The anatomy sequence surveys the gross and microscopic structure of the human body with emphasis on the structure-function relationship. This course is concerned with cell structure, histology, and tissues.

Credits: 0.00 to 2.00

College: School of Biomedical Engineering, Science & Health Systems
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BMES 602 Anatomy II

Continues BMES 601. Functional gross anatomy.

Credits: 0.00 to 2.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 603 Anatomy III

Continues BMES 602. Neuroanatomy.

Credits: 0.00 to 2.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 604 Pharmacology

Covers the interaction between chemical agents and biological systems at all levels of integration. Discusses general classes of drugs, with particular emphasis on general concepts and problems of medical importance.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 611 Biological Control Systems I

Introduces the basic concepts of feedback control systems, including characterization in terms of prescribed constraints, study of input and output relationship for various types of biological systems, and stability and time delay problems.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 612 Biological Control Systems II

Covers receptors, skeletal-muscle control systems, vestibular feedback, and sampled-data models.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 613 Biological Control Systems III

Covers mathematical models of biological systems, with emphasis on non-linear and adaptive systems study.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 621 Medical Imaging Systems I

Provides an overview of the field of medical imaging. Covers aspects of light imaging; systems theory, convolutions, and transforms; photometry, lenses, and depth of field; image perception and roc theory; and three-dimensional imaging.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 622 Medical Imaging Systems II

Introduces medical visualization techniques based on ultrasound propagation in biological tissues. Includes generation and reception of ultrasound, imaging techniques (A-mode, B-mode, M-mode, and Doppler), and typical and emerging diagnostic applications.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 623 Medical Imaging Systems III

Introduces elements of wave imaging, including wave propagation, Fourier optics and acoustics, limitations on resolution, ultrasound transducer characterization, and synthetic aperture systems. Examines MRI imaging in detail.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 625 Biomedical Ultrasound I

Focuses on the propagation of ultrasound in inhomogeneous media such as tissue, and discusses imaging principles and basics of tissue characterization. Discusses ultrasound instrumentation, including A-and B-mode scanners.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 626 Biomedical Ultrasound II

Covers the theory and construction of array transducers for imaging, Doppler ultrasound systems and their application to the study of blood flow, and continuous wave and pulsed systems and Doppler imaging.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 628 Ultsd Wv Mtn Solids/Piezo

This course provides an introduction to the physics of wave propagation in solids, acquainting the student along the way with the necessary tensor formalism. The origin and behavior of longitudinal and shear bulk waves, surface waves, and plate waves are explored.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 631 Tissue Engineering I

This course is designed to familiarize students with advanced concepts of cellular and molecular biology relevant to tissue engineering. This is the initial course in a three-course sequence combining materials from life science and engineering design. Credits: 4.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 632 Tissue Engineering II

This course familiarizes students with advanced concepts of developmental and evolutionary biology relevant to tissue engineering. The second part of a three-course sequence combines materials from cellular/molecular biology and evolutionary design.

Credits: 4.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 633 Tissue Engineering III

This is the third course in a three-course sequence on tissue engineering focusing on developments and techniques in tissue engineering and biomaterials. This course provides graduate students with detailed knowledge of factor-mediated approaches.

Credits: 4.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 641 Biomedical Mechanics I

Designed to acquaint students with the response of biological tissues to mechanical loads and with the mechanical properties of living systems. Covers topics in musculoskeletal anatomy and functional mechanics and a review of mechanical principles.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 642 Biomedical Mechanics II

Continues BMES 641.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 643 Biomedical Mechanics III

Continues BMES 642.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 644 Cellular Biomechanics

This course of cellular bioengineering focuses on mechanics and transport. Material builds upon undergraduate engineering education to place engineering mechanics into the context of biological function at the cellular level.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 651 Trans Phenom Liv Sys I

Covers physical principles of momentum, energy, and mass transport phenomena in blood and other biological fluids; diffusion and convection at the microcirculatory level; physiology of arteries and veins; and local and systemic blood flow regulation.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems

Department: School of Biomedical Engineering

BMES 660 Biomaterials I

First course in a three-quarter sequence designed to acquaint students with the behavior of materials used in biomedical application under

load (i.e., mechanical properties), their modes of failure and as a function of their environment.

Credits: 0.00 to 4.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 661 Biomaterials II

Second course in a three-quarter sequence in biomaterials. The goal of this course is with an understanding of, and ability to select, appropriate materials for specific applications taking into account mechanical, thermal, and rheological properties.

Credits: 0.00 to 4.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 662 Biomaterials III

Third course in a three-quarter sequence in biomaterials. The goal of this course is to provide students with sufficient knowledge to predict and resolve unfavorable/upcoming tissue responses to a particular material.

Credits: 0.00 to 4.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 672 Biosimulation I

This course focuses upon the mathematical analysis of biomedical engineering systems. As the first course in the biosimulation sequence, the course is a blend of analytical and numerical methods with strong emphasis on analytical approaches.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 673 Biosimulation II

The second in a two-course sequence, this course focuses upon the mathematical modeling and subsequent computational analysis of complex biological systems. Specific examples are drawn physiological systems, cellular and molecular systems, and bioimaging.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 676 Software Dev Hlth Sci Ins

This course presents the planning, development and evaluation of computer software for instruction and clinical decision support in the area of health care. Particular emphasis is given to the Macintosh computer.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 680 Special Topics

Covers topics of particular interest that may not be offered every term or every year. Also included in this category are courses under development.

Credits: 0.00 to 9.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 681 Physics of Living Systems I

Designed for the biomedical science student with a background in life sciences. Reviews and expands on basic concepts in physics as applied

in biological systems. Topics include mechanics, exponential growth and decay, and thermodynamics.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 682 Physics of Living Systems II

Covers advanced topics in biophysics for both biomedical science and biomedical engineering students.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 683 Physics of Living Systems III

Covers advanced topics of current interest in biomedical engineering.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 710 Neural Signals

This course covers aspects of neural signaling, including fundamentals of action potential generation, generator potentials, synaptic potentials, and second messenger signals. Students learn Hodgkin-Huxley descriptions.

Credits: 0.00 to 4.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 711 Principles in Neuroengineering

This course is an in-depth student of some of the cutting-edge technologies in neuroengineering. The course draws on faculty in the College of Medicine and School of Biomedical Engineering, Science and Health Systems to present and investigate topics.

Credits: 4.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 722 Neurl Aspct Post & Loco I

Studies physiology of sensory/motor systems, with emphasis on modeling of neural systems and biomechanical aspects of functional tasks. Begins with an analysis of the transportation of materials in and out of cells.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 725 Neural Networks

Explores the mathematical and biological bases for neurocomputing. Involves construction by students of computer simulations of important models and learning algorithms. Discusses applications to pattern recognition, vision, speech, and control.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 731 Adv Tops Ultrasnd Rsrch I

Explores subjects of current interest through review of the literature by faculty, students, or invited lecturers.

Credits: 3.00

College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 732 Adv Top Ultrasnd Rsch II
Continues BMES 731. Discusses current developments and research in medical and industrial ultrasound, and geophysical and underwater signal processing.
Credits: 3.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 799 Independ & Supervis Study
Course and credits arranged with individual advisers.
Credits: 0.00 to 9.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 821 Medical Instrumentation
Provides a broad overview of the applications of health care technology in diagnosis and therapy. Reflects the persuasiveness of biomedical engineering in medicine by describing medical instrumentation and engineering technology used.
Credits: 3.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 823 Medical Instrument Lab
Provides laboratory exercises, including pulmonary function testing, stress testing, EKG, electrosurgery, and x-ray.
Credits: 2.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 825 Hospital Administration
Provides an analysis of the administrative process, including planning, organization, design, decision-making, leadership, and control. Presents methodologies and techniques that can contribute to the effective performance of administrative responsibilities.
Credits: 3.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 826 Hospital Engr Management
Covers the wide range of responsibilities of a clinical engineer, including managing a clinical engineering department, setting up an electrical safety program, establishing an equipment maintenance program, and approaches for equipment acquisition.
Credits: 3.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 864 Seminar An invitation seminar for discussion of research topics in biomedical engineering and science. Attendance of all graduate students in the institute is required. (None may be repeated for credit.)
Credits: 0.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 866 Seminar II
Continues BMES 865.
Credits: 2.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 867 Seminar III
Continues BMES 866.
Credits: 2.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 897 Research
Requires investigation of a biomedical problem under the direction of a faculty adviser.
Credits: 1.00 to 12.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 898 Master's Thesis
Requires the study and investigation of a research or development problem. Requires results to be reported in a thesis under the direction of a faculty adviser. No credit granted until the thesis is completed and approved.
Credits: 0.50 to 20.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering

BMES 998 Ph.D. Dissertation
Requires the study and investigation of a research or development problem. Requires results to be reported in a dissertation under the direction of a faculty adviser. No credit granted until the dissertation is completed and approved.
Credits: 1.00 to 12.00
College: School of Biomedical Engineering, Science & Health Systems
Department: School of Biomedical Engineering