Biomedical Engineering

BMEN 1100 Introduction to Bioengineering I (1 semester credit hour) Project-based instruction. This course provides the initial introduction to biomedical engineering tools and techniques. This course will provide hands on learning in circuit design, basic analog and digital circuits, programming, sensors and actuators. The purpose of this course is to give students a basic understanding of modern engineering tools and how they interface with computers to solve bioengineering problems. CE 1100 or CS 1200 or EE 1100 or MECH 1100 can substitute for this course. Credit cannot be received for more than one of the following: BMEN 1100, CE 1100, CS 1200, EE 1100 or MECH 1100. (0-2) Y

BMEN 1208 Introduction to Bioengineering II (2 semester credit hours) Project-based instruction. The purpose of this course is to give students a general understanding of the broad range of applications specific to the biomedical engineering profession. Course exercises include team-oriented competitions, lectures by various external biomedical engineering experts, and introductory materials associated with the discipline. Perform a competitive team design project. Prerequisite: BMEN 1100. Prerequisites or Corequisites: (PHYS 2325 and PHYS 2125) and (MATH 2419 or MATH 2414). (2-1) Y

BMEN 2320 Statics (3 semester credit hours) Lecture course. Course material includes vector representations of forces and moments, free body diagrams, equilibrium of particles, center of mass, centroids, distributed load systems, equivalent force systems, equilibrium of rigid bodies, trusses, frames and machines, internal forces in structural members, shear forces and bending moments in beams, friction, area and mass moments of inertia, the principle of virtual work. Prerequisites: PHYS 2325 and PHYS 2125. Prerequisites or Corequisites: MATH 2415 or MATH 2419. (3-0) Y

BMEN 2330 Introduction to Modern Biology for Bioengineering (3 semester credit hours) Presentation of the fundamental concepts of modern biology, with an emphasis on the molecular and cellular basis of biological phenomena. Topics include molecular genetics and the chemistry and metabolism of biological molecules. Prerequisites: CHEM 1311 and CHEM 1312. (3-0) Y

BMEN 2340 General Chemistry For Bioengineering (3 semester credit hours) Presentation of the fundamental concepts of modern chemistry with an emphasis on engineering topics including: structure of atoms, covalent and ionic bonds, reactions and kinetics, bonding in semiconductors and metals, chemical equilibrium and the ideal gas law, and chemical thermodynamics. (3-1) Y

BMEN 2V99 Topics in Biomedical Engineering (1-4 semester credit hours) May be repeated as topics vary (9 semester credit hours maximum). ([1-4]-0) R

BMEN 3101 Biomechanics Laboratory (1 semester credit hour) Laboratory course. Prerequisite: RHET 1302. Corequisite: BMEN 3301. (0-1) Y

BMEN 3110 Biomedical Transport Processes Laboratory (1 semester credit hour) Laboratory

course. Prerequisite: RHET 1302. Prerequisite or Corequisite: BMEN 3310. (0-1) Y

BMEN 3120 Biomedical Circuits and Instrumentation Laboratory (1 semester credit hour) Laboratory course. This course will include a brief recitation (discussion) session prior to each lab. Prerequisite or Corequisite: BMEN 3320. Prerequisite: RHET 1302. (0-1) Y

BMEN 3130 Engineering Physiology Laboratory (1 semester credit hour) Laboratory course. Prerequisites: BMEN 3120 and BMEN 3320 and RHET 1302. Prerequisite or Corequisite: BMEN 3330. (0-1) Y

BMEN 3150 Biomedical Engineering Laboratory (1 semester credit hour) Laboratory course. Prerequiste or Corequisite: BMEN 3350. Prerequisite: RHET 1302. (0-1) Y

BMEN 3170 Digital Circuits Laboratory (1 semester credit hour) Laboratory Course. Prerequisite: BMEN 3370. (0-3) Y

BMEN 3301 Introduction to Biomechanics (3 semester credit hours) Mechanical properties of biological materials. The molecular basis for macroscopically measured quantities. Molecular mechanics (e.g. protein folding). Cellular mechanics of passive and active processes (e.g. cytoskeletal mechanics, cell migration). Simulation and numerical solution of dynamical equations arising in biomechanics. Corequisite: BMEN 3101. Prerequisites: BMEN 1208 and BMEN 2320. (3-0) Y

BMEN 3310 Fluid Mechanics and Transport Processes in Biomedical Engineering (3 semester credit hours) Introduction to fluid flow and transport phenomena in bioengineering. Fluids in biological circulatory systems, devices, and microsystems. Mass, thermal, and multiphase transport in biology. Emphasis on the use of mathematical modeling and computer simulations. Prerequisites: BMEN 3301 and ENGR 3300. (3-0) Y

BMEN 3315 Thermodynamics and Physical Chemistry in Biomedical Engineering (3 semester credit hours) An introduction to the fundamentals of thermodynamics and physical chemistry. Molecules and chemical bonds, chemical kinetics and reaction equilibria. Topics also include molecular transitions, nonequilibrium processes, self assembly, and interface thermodynamics. Credit cannot be received for both courses, BMEN 3315 and BMEN 3360. Prerequisites: (PHYS 2326 and PHYS 2126) and (CHEM 1312 and CHEM 1112) and MATH 2420. (3-0) Y

BMEN 3320 Electrical and Electronic Circuits in Biomedical Engineering (3 semester credit hours) Introduction to analysis methods and network theorems used to describe operation of electric circuits. Electrical quantities, linear circuit elements, circuit principles, signal waveforms, transient and steady state circuit behavior, diode and transistor circuits, operational amplifiers, digital logic devices. Time domain and Laplace transform methods for analysis of electric circuits. Modeling, analysis and simulation of circuits. It is recommended that students take BMEN 3120 with this course. Prerequisites: MATH 2420 and (PHYS 2126 and PHYS 2326). (3-0) Y

BMEN 3325 Advanced MATLAB Programming for Biomedical Engineering (3 semester credit hours) MATLAB programing is an increasingly important skill for Bioengineering/Biomedical Engineering

(BE/BME) students. MATLAB is both a programming language and a platform with toolboxes for data processing, visualization, and analysis. Although most BE/BME students took the introductory level course of programing at freshmen level, junior or senior students require more advanced MATLAB programming skills in their study or research. The course will provide an extensive training for MATLAB programming skills for solving biomedical problems. Advanced topics in programming and advanced computational models will be introduced with lectures. Assignments and class projects will be used for training. Students are allowed to use other programming languages in course projects, as most programming concepts are common across different programming languages. The course will help students to obtain solid programming skills to be better ready for their junior, senior, graduate study, or job. Prerequisite: BMEN 1208. (1.5-1.5) R

BMEN 3330 Engineering Physiology of the Human Body (3 semester credit hours) An introduction to the physiology of the human body for engineers. This course will cover the various levels of structural organization of the body, from molecular, cellular and tissue/organ organization to the whole body anatomy and maintenance. The role of biological principles, phenomena and technology to monitor these processes will be highlighted in engineering terms. It is recommended that students take BMEN 3130 with this course. Prerequisite: BIOL 2311. (3-0) Y

BMEN 3350 Biomedical Component and System Design (3 semester credit hours) Fundamental knowledge behind design of biomedical systems. Design and implementation of biomedical signal processing. Modeling and simulation for biomedical systems. Circuit and system design method for implantable devices. Software and hardware infrastructure for biomedical applications. Computer-aided techniques for analyzing sampled data. It is recommended that students take BMEN 3150 with this course. Prerequisites: BMEN 3320 and ENGR 3300. (3-0) Y

BMEN 3360 Thermodynamics (3 semester credit hours) Lecture course. This course focuses on introductory concepts and definitions of thermodynamics, energy and the availability of reversible work, machine, and cycle processes; real gas behavior; first law of thermodynamics, phase-change, internal energy, energy balance, entropy, ideal gas, control volume analysis, second law of thermodynamics, vapor, gas and refrigeration power systems. Credit cannot be received for both courses, BMEN 3315 and BMEN 3360. Prerequisites: ENGR 3300 and PHYS 2325. Prerequisite or Corequisite: CHEM 1311. (3-0) Y

BMEN 3370 Digital Circuits (3 semester credit hours) Digital circuit design, hardware structures, and assembly-language concepts that underlie the design of modern computer systems. Topics include: internal data representation and arithmetic operations in a computer, basic logic circuits, MIPS assembly language, and an overview of computer architecture. Boolean logic. Design and analysis of combinational logic circuits using SSI and MSI. Design and analysis of synchronous state machines. State minimization and assignment. Design of arithmetic circuits: adders, multipliers, and shifters. Prerequisites: MATH 2420 and (PHYS 2126 and PHYS 2326). (3-0) Y

BMEN 3V99 Topics in Biomedical Engineering (1-4 semester credit hours) May be repeated as topics vary (9 semester credit hours maximum). Instructor consent required. ([1-4]-0) R

BMEN 4110 Biomedical Feedback Systems Laboratory (1 semester credit hour) Laboratory course. Corequisite: BMEN 4310. Prerequisite: RHET 1302. (0-1) Y

BMEN 4310 Feedback Systems in Biomedical Engineering (3 semester credit hours) Notions of inputs, outputs, and states. Linearity versus nonlinearity. Deterministic versus stochastic systems. Top down versus bottom up modeling. Sensitivity and reduction of sensitivity via feedback. Introduction to stability. Feedback for stabilization and disturbance rejection. Numerical simulation and controller design via computational approaches. It is recommended that students take BMEN 4110 with this course. Prerequisites: ENGR 2300 and MATH 2420. (3-0) Y

BMEN 4320 Intermediate Electrical Systems (3 semester credit hours) Principles of circuit and system analysis methods used in the design and analysis of biomedical instrumentation. Circuit solution methods. Filter design methods. Special emphasis is placed on circuits commonly employed in biomedical devices, such as amplifiers and filtering networks used in electrocardiograph systems, construction and characterization of simple transducers and signal conditioning equipment for measuring biomedical parameters such as force, displacement, pressure, flow and biopotentials. Prerequisites: BMEN 3320 and BMEN 3120. (3-0) Y

BMEN 4330 Advanced Engineering Physiology of the Human Body (3 semester credit hours) Advanced extension of BMEN 3330. This course will cover in-depth examples of the human physiology with engineering terms, with specific emphasis on synthetic biology approach to biological networks and systems biology approach to complex diseases, such as cancer and mental disorders. Prerequisite: BMEN 3330. (3-0) Y

BMEN 4342 Introduction to Robotics (3 semester credit hours) Fundamentals of robotics, rigid motions, homogeneous transformations, forward and inverse kinematics, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Prerequisites: (ENGR 2300 and EE 3302) and (BMEN 4310 or EE 4310 or MECH 4310) or equivalent. (Same as EE 4342) (2-3) Y

BMEN 4350 Applied Sensor Technology (3 semester credit hours) Introduction to the basic principles and design issues of biomedical sensors and instrumentation, including: the physical principles of biomedical sensors, analysis of biomedical instrumentation systems, and the application-specific biomedical sensor and instrumentation design. Topics include: basic concepts of sensors and instrumentation, membrane biophysics, action potentials, biopotential electrodes. Prerequisites: (BMEN 3320 and BMEN 3120) and (BMEN 3330 and BMEN 3130). (3-0) Y

BMEN 4360 Biomaterials and Medical Devices (3 semester credit hours) Introduction to the field of biomaterials used in the design and engineering of medical devices, and to augment or replace soft and hard tissues. Discussion of bulk properties, applications, and in vivo behavior of different classes of natural and synthetic biomaterials. Analysis of biological response and biocompatibility, degradation and failure processes of implantable biomaterials/devices. Overview of regulatory compliance and performance requirements for commercialization of biomaterials and medical devices. Prerequisites or Corequisites: BMEN 2320 and CHEM 1312. (3-0) Y

BMEN 4388 Senior Design Project I (3 semester credit hours) First of two sequential semesters devoted to a team project that engages students in the full engineering design process. The goal of senior design projects is to prepare the student to run/participate in engineering projects related to an appropriate industry. Thus, all project teams are to follow standard industrial practices and methods. Teams must carry the engineering project to completion, examining real world and

multiple design constraints, following applicable industrial and business standards. Such constraints may include but are not limited to: economic, environmental, industrial standards, team time/resource management and cross-disciplinary/departmental result integration. Students are required to work in teams that include collaborative design interaction. Additionally, cross-disciplinary/departmental teams are encouraged but not required. In Senior Design I, project proposals will be written, reviewed and approved. Initial designs will be completed and corresponding constraints will be determined. All students will participate in a public oral and poster presentation following departmental approved guidelines at a departmental approved time and location. Teams will also submit a written end of semester progress report and documented team communication (complete sets of weekly reports and/or log books) following guidelines approved by the faculty. Prerequisites: BMEN 3320 and BMEN 3330 and BMEN 3350 and ECS 3390. (3-0) Y

BMEN 4389 Senior Design Project II (3 semester credit hours) Continuation of the Senior Design project begun in the previous semester. In Senior Design II, projects based on approved project proposals will be completed. All limitations of the design will be determined and addressed. All students will participate in a public oral presentation following faculty-approved guidelines at a faculty-approved time and location. Teams will also submit a written final report and documented team communication (complete sets of weekly reports and/or log books) following faculty-approved guidelines. Prerequisite: BMEN 4388. (3-0) Y

BMEN 4399 Senior Honors in Biomedical Engineering (3 semester credit hours) For students conducting independent research for honors theses or projects. Instructor consent required. (3-0) R

BMEN 4V95 Undergraduate Topics in Biomedical Engineering (1-9 semester credit hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary (9 semester credit hours maximum). Instructor consent required. ([1-9]-0) R

BMEN 4V97 Independent Study in Biomedical Engineering (1-9 semester credit hours) Independent study under a faculty member's direction. May be repeated for credit as topics vary (9 semester credit hours maximum). Instructor consent required. ([1-9]-0) R

BMEN 4V98 Undergraduate Research in Biomedical Engineering (1-9 semester credit hours) This course may be used as an honors course. May be repeated for credit as topics vary (9 semester credit hours maximum). Instructor consent required. ([1-9]-0) R