Biomedical Engineering

**BMEN 1208** Introduction to Biomedical Engineering (2 semester 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: **ECS 1200**. Prerequisites or corequisites: PHYS 2325 and PHYS 2125 and (MATH 2419 or MATH 2414). (1-1) Y

**BMEN 2310** Static Equilibrium and Rigid Body Dynamics (3 semester hours) Lecture course. Course material includes static equilibrium of particles, trusses and machines. Friction equivalent systems, particle dynamics in one, two and three dimensions, work, energy, angular momentum and moment of inertia, and dynamics of rigid bodies. Prerequisites or corequisites: ENGR 2300 and MATH 2420, and (PHYS 2326 and PHYS 2126). (3-0) Y

**BMEN 2v99** Topics in Biomedical Engineering (1-4 semester hours) May be repeated as topics vary (9 hours maximum). ([1-4]-0) R

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

**BMEN 3110** Biomedical Transport Processes Laboratory (1 semester hour) Laboratory course. Corequisite: BMEN 3310. Prerequisite: RHET 1302. (0-1) Y

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

**BMEN 3130** Engineering Physiology Laboratory (1 semester hour) Laboratory course. Corequisite: BMEN 3330; Prerequisite: RHET 1302. (0-1) Y

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

**BMEN 3301** Introduction to Biomechanics (3 semester 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**. Prerequisite: BMEN 2310; Prerequisite or corequisite: BMEN 1208. (3-0) Y

**BMEN 3310** Fluid Mechanics and Transport Processes in Biomedical Engineering (3 semester 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. Corequisite: BMEN 3110. Prerequisites: ENGR 3300 and BMEN 3301. (3-0) Y
BMEN 3315 Thermodynamics and Physical Chemistry in Biomedical Engineering (3 semester 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. Prerequisites: BMEN 1208 and (CHEM 1312 and CHEM 1112) and MATH 2420. (3-0) Y

BMEN 3320 Electrical and Electronic Circuits in Biomedical Engineering (3 semester 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. Corequisite: BMEN 3120; Prerequisites: MATH 2420 and (PHYS 2326 and PHYS 2126). (3-0) Y

BMEN 3330 Engineering Physiology of the Human Body (3 semester 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 and phenomena will be highlighted in engineering terms. Corequisite: BMEN 3130. Prerequisites: (BIOL 2312 and BIOL 2112 and BIOL 2281) and BMEN 1208 and BMEN 3315. (3-0) Y

BMEN 3350 Biomedical Component and System Design (3 semester 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. Corequisite: BMEN 3150; Prerequisites: BMEN 3301 and BMEN 3310. (3-0) Y

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

BMEN 4310 Feedback Systems in Biomedical Engineering (3 semester 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. Corequisite: BMEN 4110; Prerequisites: ENGR 2300 and MATH 2420. (3-0) Y

BMEN 4320 Intermediate Electrical Systems (3 semester 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 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 4350 Applied Sensor Technology (3 semester hours) Introduction to the basic principles and design

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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 4388** Senior Design Project I (3 semester 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/departamental result integration. Students are required to work in teams that include collaborative design interaction. Additionally, cross-disciplinary/departamental 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 3315 and BMEN 3320 and BMEN 3330 and BMEN 3350 and ECS 3390. (3-0) Y

**BMEN 4389** Senior Design Project II (3 semester 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 hours) For students conducting independent research for honors theses or projects. This course may be used as an honors course. (3-0) R

**BMEN 4v95** Undergraduate Topics in Biomedical Engineering (1-9 semester hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary (9 hours maximum). ([1-9]-0) R

**BMEN 4v97** Independent Study in Biomedical Engineering (1-9 semester hours) Independent study under a faculty member's direction. May be repeated for credit as topics vary (9 hours maximum). Instructor consent required. ([1-9]-0) R

**BMEN 4v98** Undergraduate Research in Biomedical Engineering (1-9 semester hours) May be repeated for credit as topics vary (9 hours maximum). This course may be used as an honors course. ([1-9]-0) R