Course Profile: Biomedical Engineering Program

COURSE: BIOMEDE 417 (EECS 417)	**COURSE TITLE:** ELECTRICAL BIOPHYSICS
TERMS OFFERED: Winter **TEXTBOOK** (Suggested Text Only): Cellular Biophysics by Wiess, vol. 2.	**PREREQUISITES:** BIOMEDE 211, or EECS 314, or EECS 215, or graduate standing **COGNIZANT FACULTY:** Charles A. Cain **DATE OF PREPARATION:** 5/01/05
INSTRUCTOR(S): Charles A. Cain	**SCIENCE/DESIGN:** 4/0
COURSE DESCRIPTION: Electrical biophysics of nerve and muscle; electrical conduction in excitable tissue; quantitative models for nerve and muscle, including the Hodgkin Huxley equations; biopotential mapping, cardiac electrophysiology, and functional electrical stimulation; group projects. Lecture and recitation.	**COURSE TOPICS:** Voltage sensitive ion channels: structure and function; excitable membranes; ionic basis for excitability; Hodgkin-Huxley model; single channel currents; stochastic channels; synaptic transmission: presynaptic, release, postsynaptic; extracellular fields; linear systems review; modeling of biological systems; time delays in biosystems; transfer function models of biosystems; systems identification; stability of feedback biosystems; cable theory; derivation of cable equation; finite cables and branching structures; cable responses to inputs: transient and steady state.

COURSE OBJECTIVES*	1. To generate a physical understanding of the structure and function of excitable cells. 2. To generate an appreciation for quantitative modeling and engineering methods applied to biological systems. 3. To generate a strong appreciation of biology as beautifully engineered systems from the level of protein molecular machines to whole organisms. 4. To teach (and review) engineering concepts useful in analyzing, describing, and understanding, biological systems. 5. To generate an appreciation for what biological systems can teach us about engineering systems, and vice versa. 6. To appreciate design in nature.

COURSE OUTCOMES*	1. Learn basic anatomy and physiology of electrically excitable systems in biology. 2. Learn the molecular basis for electrical excitability. 3. Develop an understanding for current flow in excitable cells. 4. Understand the probabilistic nature of individual ion channel function. 5. Understand the Hodgkin-Huxley and other successful quantitative models of cellular excitability. 6. Understand how basic linear systems approaches can be applied to modeling biological systems. 7. Understand simple systems identification techniques applied to biological systems. 8. Understand time delays, gain, and stability in biological feedback systems. 9. Understand electrical signals in passive cable-like cellular structures. 10. Understand electrical modeling of branching passive cellular structures.
ASSESSMENT TOOLS	1. Extensive class project 2. Two extensive take home exams using outcomes of the class project 3. Project presentations 4. Comprehensive homework assignments with problem solving and written essays on course related topics 5. Classroom discussion and participation