BME425

Course Syllabus

1. *Department*: Biomedical Engineering *Number*: BME425 *Credit Hours*: 3
Title: Bioelectricity *Required*

2. *Course Description*:
Quantitative analysis of excitable membranes and their signals, including plasma membrane characteristics, origin of electrical membrane potentials, action potentials, voltage clamp experiments, the Hodgkin-Huxley equations, propagation, subthresholdstimuli, extracellular fields, membrane biophysics, and electrophysiology of the heart. Design and development of an electrocardiogram analysis system.

3. *Prerequisite(s)*: BME 302 or (ZO 421 and a course in electrical circuits)

4. *Textbook(s) and/or other required material*:
Bioelectricity: A Quanitative Approach, Robert Plonsey and Roger C. Barr, 2nd edition, Plenum Press, New York and London, 2000.

5. *Course objectives. By the end of this course, the student should be able to: (use demonstrative verbs)*
Explain how membrane potentials are generated and describe this process mathematically; Describe how muscle and nerve action potentials are generated, recorded, and modeled; Describe how voltage clamp experiments are carried out; Use the Hodgkin-Huxley model and plasma membrane structure to explain the main characteristics of action potentials; Use the linear core-conductor model to demonstrate action potential propagation; Determine the extracellular potential at a field point that is due to a propagating action potential; Describe a propagating action potential in terms of dipole models; Briefly describe the important characteristics of different computers models of action potentials; Complete a project related to electrophysiology; Present the major findings of the project to class.

6. *Topics covered (give the number of lectures per topic, as well as the total number of lectures per semester)*:
Total of 30 lectures (in parentheses): Introduction to Electrical Fields(1); Bioelectric Potentials and Currents(2);Channels(2); Action Potentials(5);Impulse Propagation(2); Chapters 1 and 2 Revisited(1);Electrical Stimulation of Excitable Tissue(3);Extracellular Fields(3);Cardiac Electrophysiology(3); The Neuromuscular Junction(2); Skeletal Muscle(1); Functional Electrical Stimulation(2); Exams (2 plus final exam).

7. *Class/laboratory schedule (sessions per week and duration of each session)*:
Two 75 minute class periods twice a week.

8. *Contribution of this course to the professional component (ABET Criterion 4)*
General comments: None

Professional component	**Course content related to professional component**
Basic math and science, some experimental (1 yr. required).	
Engineering science and design (1.5 yrs. required)	This course contributes to 3 hours of engineering science.
General education requirement	

9. *Relationship of this course to program learning outcomes*:
Text description (optional): None

Learning Outcome	**Level of Instruction**	**Course content related to outcome implementation/assessment**
Outcome A	Major	Explain how membrane potentials are generated and describe this process mathematically using the Nernst equation and Hodgkin-Huxley model. Describe how voltage clamp experiments are carried out and the important results that were learned from early experiments. Use the linear core conductor model to describe action potential propagation and determine the extracellular potential due to a propagating action potential at a field point away from the source. Briefly describe the important characteristics of different computer models of cardiac action potentials.Describe how plasma membranes maintain intracellular ion concentrations. Explain how membrane potentials are generated and describe this process mathematically using the Nernst equation and Hodgkin-Huxley model. Describe how voltage clamp experiments are carried out and the important results that were learned from early experiments. Briefly describe the electrophysiology of the heart and how electrocardiograms are generated and measured.
Outcome E	Major	identify, formulate and solve engineering problems
Outcome G	Basic	communication -- homework assignments
Outcome J	Intermediate	machine man interfaces
Outcome K	Major	Matlab

10. *Date of preparation and person(s) who prepared this description*:
Lesley H. Hubbard, January 5, 2003. Last edited on January 8, 2004. Last edited on February 9, 2004. Last edited on August 11, 2006 by Lianne Cartee.