ECE 795 Quantitative Electrophysiology 2011

Instructor: H. de Bruin

Pre-requisites: A basic undergraduate understanding of electrostatics, electrical circuits, linear systems, and ordinary & partial differential equations.

Course description: This course provides a solid quantitative understanding of the behaviour of excitable cells, the resulting extracellular fields, the measurement of extracellular fields using techniques such as EMG and EEG, and functional electrical stimulation of excitable cells for neural and muscular prostheses.

Course outline:

1) Introduction to excitable cells
   Equivalent electrical circuits for cell membranes
2) Cell excitability
   Introduction to the Hodgkin-Huxley model
3) Linear cable equations
   Propagation of electrical potential waveforms
4) Chemical synapses and gap junctions
   Dendritic trees
5) Muscle physiology (skeletal and cardiac)
6) Models for generation of extracellular fields
7) Electromyography (EMG)
8) Electroencephalography (EEG)
9) Measurement of bioelectric potentials (electrodes, differential amplification, filtering, data acquisition, etc
10) Electrodes and sources for functional electrical stimulation (FES)
11) Fundamentals of FES
12) Applications of FES

References:

R. Plonsey and R. C. Barr , "Bioelectricity: A Quantitative Approach," 2nd Edition, Kluwer Academic/Plenum Publishers, 2000.

D. Johnston and S. M.-S. Wu, "Foundations of cellular neurophysiology," MIT Press, 1994.

C. Koch, "Biophysics of computation: information processing in single neurons," Oxford University Press, 1998.

J. Malmivuo and R. Plonsey, “Bioelectromagnetism: Principles and Applications of Bioelectric and Biomagnetic Fields, Oxford University Press, 1995

Assessment: Final Exam 60%, Project 40%

Term: I