BMED/ECE 4784 Engineering Electrophysiology

Credit: 3-0-3

Prerequisite(s): ECE 3040 or BMED 3510

Catalog Description
Basic concepts of electrophysiology from an engineering perspective. Students learn the function of relevant organs and systems and the instrumentation tools which monitor electrophysiological function.

Text
Bioelectricity: A Quantitative Approach, R. Plonsey and R. Bar, 2nd edition, 2000

Objectives
The overall objective of this course is to introduce students 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

Outcomes
By the end of the course the students will understand the:

1. basic concepts of electrophysiology (Program Outcome 1)
2. analogies between active/passive electrical circuits and electrophysiology (Program Outcome 1)
3. function of organs and systems in the body relevant to electrophysiology (Program Outcome 1)
4. tools used to monitor and quantify the electrophysiological properties of biological systems (Program Outcomes 1 and 2)

Topical Outline

1. Membrane biophysics
   a. Diffusion across a cell membrane
   b. Nernst potentials
   c. Diffusion potentials
   d. Goldman equation
2. Action potentials
   a. Membrane behavior
   b. Origin of action potentials
   c. Hodgkin-Huxley equations
   d. Modeling
   e. Propagation of action potentials
   f. Subthreshold stimuli
3. Extracellular fields
   a. Monopole and dipole models
4. Cellular analysis technologies

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    a. Coulter counter
    b. Impedance spectroscopy
    c. Fluorescence spectroscopy
    d. Molecular tagging
    e. Electrodes
5. Electrophysiology of the heart
    a. Anatomy/physiology of the heart
    b. Heart vector
    c. Electrode configurations
    d. Recording
    e. Body surface potentials
    f. Interface electronics
6. Neuromuscular junction
    a. Transmitters
    b. Poisson statistics
    c. Post-junctional responses
7. Skeletal muscle
    a. Anatomy/physiology of muscle
    b. Myofibrils and filaments
    c. Excitation contraction
8. Functional neuromuscular stimulation
    a. Electrodes
    b. Nerve excitation
9. Interface circuitry/systems
    a. Neurophysiological analysis systems
    b. Skeletal muscle interfaces
    c. Blood analysis
10. Advanced electrophysiological analysis systems
    a. Micro systems
    b. Metabolite monitoring
    c. Prosthetic devices / bionics