

## **BMED 4781 Biomedical Instrumentation {elective}**

**Credit:** 3-0-3

**Prerequisite(s):** ECE 3040 or ECE 3710

### **Catalog Description**

A study of medical instrumentation from a systems viewpoint. Pertinent physiological and electro-physiological concepts will be covered. Crosslisted with ECE, CHBE and ME 4781.

### **Text**

*Medical Instrumentation: Application and Design* (4th edition), J. Webster, ed., John Wiley & Sons, Hoboken, NJ, 2009

### **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 be able to:

1. classify systems modeling biomedical sensors and instrumentation (Program Outcomes 1 & 2)
2. calculate the static and dynamic characteristics of bioinstrumentation systems (Program Outcomes 1, 2 & 4)
3. design simple analog circuits (e.g. instrumentation amplifiers and active filters) used in bioinstrumentation (Program Outcomes 2 & 4)
4. apply sampling theorem fundamentals to design A/D conversion processes for biomedical signal acquisition (Program Outcomes 2 & 4)

### **Topical Outline**

1. Basic Concepts of Instrumentation
  - a. Static and dynamic characteristics
  - b. Design criteria
  - c. Instrumentation Amplifiers
2. Membrane Biophysics
  - a. Diffusion across cell membranes
  - b. Nernst potentials
  - c. Diffusion potentials
  - d. Goldman equation
3. Action Potentials
  - a. Membrane behavior
  - b. Origin of action potential
  - c. Hodgkin-Huxley equations

- d. Modeling
- e. Propagation of action potentials
- f. Subthreshold stimuli
- 4. Biopotential Electrodes
  - a. Fundamentals
  - b. Body surface electrodes
  - c. Microelectrodes
- 5. Electrophysiology of the Heart
  - a. Anatomy/physiology of heart
  - b. Body surface potentials
  - c. Electrocardiogram
  - d. Heart vector
  - e. Standard leads
- 6. Electrophysiology of Neuromuscular System
  - a. Neuromuscular Junction
  - b. Transmitters
  - c. Poisson statistics for transmitters
  - d. Postjunctional response
  - e. Anatomy/physiology of muscle
  - f. Myofibrils and filaments
  - g. Excitation contraction
  - h. Electromyography
  - i. Functional neuromuscular stimulation
- 7. Miscellaneous Electrophysiology
  - a. Electroencephalography
  - b. Electroretinogram
- 8. Biomedical Transducers
  - a. Displacement transducers
  - b. Thermocouples and thermistors
- 9. Measurement of Blood and Gas Flows
  - a. Electromagnetic flowmeter
  - b. Ultrasonic flowmeter
  - c. Thermodilution catheter