

BIME 4200 Biomedical Instrumentation

This course is required for the Biomedical Engineering concentration.

Course Coordinator:

Loren Limberis

Catalog Description:

Instrumentation and techniques used in acquisition, processing, and presentation of biomedical signals: transducers, sensors, Fourier analysis, flow measurement, medical imaging, biosensors, amplifiers, bridge circuits, and measurement of physical parameters and electrophysiological signals.

Course Structure:

Three 50-minute lectures, one two hour lab (four credits)

Prerequisites:

BIME 4040, ICEE 3050

Required texts:

Medical Instrumentation: Application and Design, 3rd Ed by John G. Webster (Editor), Wiley, 1997.

Course Objectives:

Upon completion of this course each student will be able to:

- Describe the principles of biomedical measurement systems
- Describe and apply the signal amplification and processing that is common to many medical instruments
- Describe and apply the basic mechanisms and principles of sensors to convert physiological events to electric signals in a number of medical instruments
- Summarize the origin of biopotentials and various bioelectric signals that are recorded routinely in modern clinical practice
- Describe the basic mechanisms involved in the transduction process of biopotential electrodes and be able to discuss electrical characteristics of electrodes
- Measure and record bioelectric signals using biopotential electrodes
- Describe the basic requirements and features of biopotential amplifiers
- Design bioamplifiers that meet specific criteria and given specifications
- Describe the various techniques of measuring blood flow and volume
- Describe and apply the basic mechanisms and principles of chemical biosensors
- Summarize the concepts and mechanisms of various clinical laboratory instrumentation
- Describe and apply the safety issues, safe design, and safe use of medical instrumentation, specifically electrical safety, and learn how to incorporate safety features into the design
- Design and apply signal acquisition programs using LabVIEW
- Design an instrument that can be used to analyze heart rate with exercise using appropriate bioamplification and filters, biopotential sensors, and data acquisition programs
- Design an instrument that can be used to estimate muscle force using appropriate bioamplification and filters, biopotential sensors, and data acquisition programs
- Identify the parameters constraining the resolution of an MRI image.
- Identify the parameters constraining the resolution of an ultrasound image.
- Describe situations when CT imaging is preferred to MRI imaging.

Course Outline

Topics covered in this course include:

- Basic concepts of medical instrumentation
- Amplifiers and signal processing
- Basic sensors and principles
- Origin of biopotentials
- Electrophysiological signals (EEG, EMG, ECG)
- Biopotential electrodes
- Biopotential amplifiers
- Transient protection, common-mode, signal processors for biopotentials, biotelemetry
- Measurement of flow and volume of blood
- Chemical biosensors: electrochemical sensors, ion-sensitive field-effect transistor (ISFET)
- Immunologically sensitive field-effect transistor (IMFET)
- Blood-gas monitoring and blood glucose sensors
- Clinical laboratory instrumentation: spectrophotometry, automated chemical analyzers
- Chromatography, electrophoresis, hematology
- Electrical safety: physiological effects of electricity, macro- and microshock hazards, protection, electrical safety codes and standards
- Experimental report writing and presentations
- Biomedical imaging methods

Relevant Program Outcomes:

Graduates of the BS in Engineering Program will demonstrate:

c) Graduates of the Engineering Program will demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

L1) Measurements on and interpretation of data from living systems

L3) Capability to apply advanced math, science and engineering at the interface of engineering and biology

Professional Component Content:

Math/Science: 0; Engineering: 4 cr; General Education: 0

Assessment Requirements:

Student Work Samples

- Instrumentation design project and report (Outcomes c, L1, and L3)

Student Course Survey

Last Review:

October 15, 2008 by Paul Kauffmann