

BMED 3500 Biomedical Sensors and Instrumentation

Credit: 2-3-3

Prerequisite(s): ECE 2025 and ECE 3741(w/concurrency) and BMED 2300 and CEE/ISYE/MATH 3770 (w/concurrency)

Catalog Description

A study of basic concepts, analysis, and design of electronic sensors and instrumentation used in biomedical measurements. Standard clinical measurement techniques will also be examined.

Text

Bioinstrumentation, J. Webster, ed., John Wiley & Sons, Hoboken, NJ, 2004

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. use LaPlace Transforms to analyze and solve mathematical models of sensors and instrumentation (Program Outcomes 1 & 2)
3. measure the static and dynamic characteristics of bioinstrumentation systems (Program Outcomes 1, 2 & 4)
4. design simple analog circuits (e.g. instrumentation amplifiers and active filters) used in bioinstrumentation (Program Outcomes 2 & 4)
5. apply sampling theorem fundamentals to design and implement A/D conversion processes for biomedical signal acquisition (Program Outcomes 2 & 4)
6. design and conduct experiments involving biomedical sensors (e.g. biopotential, pressure, force, displacement, and/or blood and gas flow sensors) as well as to measure and interpret experimental data from living systems (Program Outcomes 2 & 4)
7. complete an open-ended team-based design project that will culminate in a poster presentation (Program Outcomes 1, 2, 4, 5, & 6)

Topical Outline

1. Representation of Systems
 - a) Forms of mathematical models
 - b) System classification
2. LaPlace Transforms
 - a) Definition and properties

- b) Convolution integral
- c) Important transform pairs
- d) Inverse transforms
- 3. Biopotential Sensors
 - a) Electrodes
 - b) Applications
- 4. Bioinstrumentation Systems
 - a) Basic Concepts & Characteristics
 - b) Single-Time Constant Circuits
 - c) Review of Op Amp Fundamentals
 - d) Signal Conditioning
 - e) Digital Signal Processing
- 5. Pressure, Force and Displacement Sensors
 - a) Transduction method
 - b) Applications
- 6. Blood and Gas Flow Sensors
 - a) Electromagnetic flowmeter
 - b) Ultrasonic flowmeter
 - c) Thermodilution catheter

Laboratory Modules

1. Review of concepts and instrumentation
2. Introduction to LabVIEW
3. Frequency analysis of biopotentials
4. Dynamic modeling of analog filters
5. Dynamic modeling of the kinetic response of a thermistor
6. Modeling and analysis of biopotential electrodes
7. Bandpass filters for ECG applications
8. Pressure Sensors for phonocardiogram (PCG) measurement
9. Design project