

ECE581/BIOM581 Sensor Circuit Fundamentals

Course Description: Introduction of fundamental circuit concepts used in sensors. The module will include review of basic circuit elements of resistors, capacitors, and MOS (Metal-Oxide-Semiconductor) transistors. Concepts of MOS circuits for signal conditioning and amplification will be introduced to illustrate how sensor's backend signal processing for current and voltage is carried out after the sensor signal transduction stage. This module serves as an intermediate level module for the NSF sponsored GAUSI program.

Prerequisite Courses: BIOM 101 OR LIFE 102 OR instructor permission (in case of H.S. biology); PH 142; MATH 255 or MATH 261; Concurrent registration in MATH 340 OR MATH 345

Course Learning Objectives

Upon successful completion of this course students will be able to...

- 1) Describe typical circuit elements used in biosensor designs and their basic functionality.
- 2) Describe typical signal conditioning and amplification circuits used in biosensor designs.
- 3) Draw typical biosensor circuit diagrams to perform signal amplification and signal conditioning functions
- 4) Perform first-order calculations of fundamental sensor circuit parameters such as gain, frequency response, and noise performance.

Course Content

Learning Objectives	Content/Topics	Objective Level
1	Review of basic operations of fundamental circuit elements. They include resistors, capacitors, and MOS transistors.	Mastery
2	Basic circuit amplification circuits. They include voltage amplifiers and transimpedance amplifiers, and output stage driver circuits	Mastery
3	Combinations of different circuit stages (amplifiers + output drivers) to form a practical sensor circuit.	Engagement
4	Fundamental parameters describing the performance of sensor circuits. They include voltage gain, transimpedance gain, input referred noise, signal-to-noise ratio (SNR), power consumption, and linearity.	Engagement
5	Review of some practical sensor circuit design examples from two different applications: electrochemical sensor, and oxygen sensor	Engagement

Assessment Components	Percentage of Grade
Final exam or project	40
Homework	40
Quizzes, optionally including clicker participation	20

Textbooks and Course Materials: A set of slides and reading materials prepared by the instructor and sold by the Bookstore.