

ECE527C/BIOM527C 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 GAUSSI 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. Identify, formulate, and solve engineering problems related to affinity sensors by applying principles of engineering, science, and mathematics
2. Apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, economic, and other factors as appropriate to the discipline
3. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
4. Communicate effectively with a range of audiences
5. Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
6. Recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge
7. Function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment

Specifically, the following topics are covered and their learning objective levels are expected.

Week	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

Grading Policy

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.