

BIEN 3410

Introduction to Bioinstrumentation and Bioimaging

The Hong Kong University of Science and Technology, Fall 2023–2024

Course Syllabus

Teaching Team

Instructor:

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Course Description

This course is designed to introduce various biosensing and bioimaging devices to senior undergraduate students. The devices include electrical, chemical, optical, and acoustic devices that can measure electroencephalogram (EEG), electromyogram (EMG) and electrooculogram (EOG), oxygen saturation, blood glucose level, blood components, scattering/absorptive biological tissues, and labeled/unlabeled cells. Students will be able to understand, design, and evaluate devices that can acquire biological information from the human body.

Prerequisites

BIEN 2410 – Cellular and Systems Physiology for Engineers.

Expected Learning Outcomes

By the end of this course, students should be able to:

- Describe the working principles of widely used bio/biomedical instrumentation and imaging technologies
- Design and evaluate devices that can acquire biological information from the human body
- Understand how bio/biomedical instruments and imaging technologies address clinical needs in practice
- Perform calculations to evaluate the performance of biosensing and bioimaging devices

Assessment Methods

The course is letter-graded. The final grade will be awarded based on performance in the following categories, with weights in parentheses:

Class participation (10%, in-class Canvas/participation)

Homework (15%, 3 sets, 5% for each HW1–HW3)

Group project (Total 25%, 10% report, 15% PowerPoint presentation)

In-class midterm examination (35%)

Take home final examination (15%)

****All homework, reports, should be submitted through Canvas****

Graded homework submitted after the deadline will receive no credit. No exceptions.

Class participation will be graded on the basis of Canvas responses.

You are expected to follow academic integrity rules: <http://www.ust.hk/vpao/integrity>. Please pay special attention to the offense of plagiarism, which involves claiming credit for others' work as if it is your own, e.g. copying the homework of your classmate, using the information on the internet without referencing the source. Serious offenders will be referred to the University for disciplinary action.

Textbooks

1. "Introduction to Biophotonics", Paras N. Prasad, Wiley; (2003)
2. "Understanding Biophotonics: Fundamentals, Advances, and Applications", Kevin Tsia, Jenny Stanford Publishing (2015)
3. "Medical Instrumentation Application and Design", John G. Webster, Wiley; 4th edition (2009)

Tentative Course Schedule

This is only tentative and is subject to revision without prior notice. Updated schedules will be announced and posted on Canvas.

Topics
01. Course overview
02. What are bioinstrumentation and bioimaging?
03. Module 1: Bioimaging (1) – Geometrical (Ray) Optics

04. Module 1: Bioimaging (2) – Optical Microscopy
05. Module 1: Bioimaging (3) – Wave Optics
06. Module 1: Bioimaging (4) – Interference
07. Module 1: Bioimaging (5) – Optical Coherence Tomography
08. Module 1: Bioimaging (6) – Fluorescence Microscopy
09. Module 1: Bioimaging (7) – Fiber Endoscopy
10. Module 1: Bioimaging (8) – Nonlinear Microscopy
11. Module 1: Bioimaging (9) – Photoacoustic Tomography
12. <i>Bioimaging research sharing: sharing by professors or postgraduate students</i>
13. <i>Midterm examination – REVIEW</i>
14. <i>Midterm examination</i>
15. Module 2: Bioinstrumentation (1) – Fundamentals of Electric Circuit
16. Module 2: Bioinstrumentation (2) – Bioelectric Phenomena (Part I)
18. Module 2: Bioinstrumentation (3) – Bioelectric Phenomena (Part II)
19. Module 2: Bioinstrumentation (4) – EEG, EMG, and EOG
20. Module 2: Bioinstrumentation (5) – Pulse Oximetry
21. Module 2: Bioinstrumentation (6) – Blood Glucose Sensor
22. Module 2: Bioinstrumentation (7) – Flow Cytometry
23. Module 2: Bioinstrumentation (8) – DNA Microarray (Part I)
24. Module 2: Bioinstrumentation (9) – DNA Microarray (Part II)
25. Project presentation