

BIEN 3410 (3 Credits)

Introduction to Bioinstrumentation and Bioimaging

The Hong Kong University of Science and Technology

Course Syllabus

Teaching Team

Instructor:

- Prof. Terence T. W. WONG (Rm 5579, 2358-6929, ttwong@ust.hk, by appointment)

Postgraduate teaching assistant (PG TA):

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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:

1. Describe the working principles of widely used bio/biomedical instrumentation and imaging technologies
2. Design and evaluate devices that can acquire biological information from the human body

3. Understand how bio/biomedical instruments and imaging technologies address clinical needs in practice
4. Perform calculations to evaluate the performance of biosensing and bioimaging devices

Course Requirements

Lectures

Tuesday and Thursday, 3:00–4:20 pm (Room 6602, face-to-face). Our lectures will be in a variety of formats: lectures, student presentations, class discussions, and exercises that we do together. Actively participating in class is the most important way you will learn in this course.

Class participation

From time to time, there will be in-class Canvas “Quizzes”. You are highly encouraged to show up in the class and answer questions accordingly.

Tutorials

There will be regular tutorials on Thursday, 1:30–2:20 pm (G009B, CYT Bldg, face-to-face), every time when I release the HW1–HW3 to you (**i.e., only 3 tutorials in total**). During a tutorial, the TA will go through some practice questions with you, which should be helpful for your homework and clear some misconceptions. We will NOT count any class participation for the tutorial.

Homework

There will be homework assignments (3 sets), distributed throughout the semester, for you to practice what we learn in class. All the homework will be graded.

Group project (a group of 2 students)

You are required to understand the core technologies developed/used by a current bioengineering, biomedical or healthcare company in the industry by (1) identifying your interested technology (related to bioinstrumentation/bioimaging), (2) identifying your interested company, (3) studying their core technology, (4) describing briefly the specific problem that the company/technology is going to solve, (5) studying their competitors, and (6) explaining, comparing, and elaborating in the report (2 pages). An oral presentation with PowerPoint (total: 4 mins, including a 3-min presentation and 1-min Q&A) is required at the end of the semester.

4-min Oral Presentation (with PowerPoint):

Imagine that you and your teammates are the CEO and CTO of the company that you have been focusing on. Convince the investors (audience) that your company and your

product are going to have a huge impact on the bio/medical community so that the investors should invest in you and your company.

You are required to submit a title and a short abstract (no more than 200 words) of the project that you plan to do (including (1) which tool in bioinstrumentation/bioimaging, (2) what specific problem you would like to focus on, and (3) what is the name of the core technology, etc). Although this homework does not count towards the final grade of the project, we will use it to assess your understanding of the project.

Examinations

There will be only an in-class midterm examination. The final examination is a take-home final examination (extended version of homework) that should be handed in within 24 hours when I post it online.

Open books and open notes for the midterm examination (**no internet access)

***Open books, open notes, and open internet for the take-home final examination

Grading Policy

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, and reports, should be submitted through Canvas****

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

Class participation will be graded based on 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, or 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)

Course AI Policy

The use of Generative AI in projects is permitted with proper acknowledgement and will NOT be contributed to the students' work.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to [Academic Integrity | HKUST – Academic Registry](#) for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

Tentative Course Schedule

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

Date	Topics (<i>tentative</i>)	Remarks
Week 1 (3 Sep)	01. Course overview	
Week 1 (5 Sep)	02. What are bioinstrumentation and bioimaging?	
Week 2 (10 Sep)	03. Module 1: Bioimaging (1) – Geometrical (Ray) Optics	
Week 2 (12 Sep)	04. Module 1: Bioimaging (2) – Optical Microscopy	
Week 3 (17 Sep)	05. Module 1: Bioimaging (3) – Wave Optics	Release of Homework 1; **Tutorial on 19 Sep
Week 3	06. Module 1: Bioimaging (4) – Gaussian Beam Optics and Interference	

(19 Sep)		
Week 4 (24 Sep)	07. Module 1: Bioimaging (5) – Optical Coherence Tomography	Homework 1 (Due date)
Week 4 (26 Sep)	08. Module 1: Bioimaging (6) – Fluorescence Microscopy (Part I)	
Week 5 (3 Oct)	09. Module 1: Bioimaging (7) – Fluorescence Microscopy (Part II)	
Week 5 (8 Oct)	10. Module 1: Bioimaging (8) – Nonlinear Microscopy	Forming Your Group (Due date)
Week 6 (10 Oct)	11. Module 1: Bioimaging (9) – Fiber Endoscopy	
Week 6 (15 Oct)	12. Module 1: Bioimaging (10) – Photoacoustic Tomography	Release of Homework 2; **Tutorial on 17 Oct
Week 7 (17 Oct)	13. Module 1: Bioimaging (11) – Photoacoustic Tomography	
Week 7 (22 Oct)	14. Bioimaging research sharing: sharing by professors or postgraduate students	Homework 2 (Due date)
Week 8 (24 Oct)	15. Midterm examination – REVIEW	Taught by TA +/- one week
Week 8 (29 Oct)	16. Midterm examination	
Week 9 (31 Oct)	17. Module 2: Bioinstrumentation (1) – Fundamentals of Electric Circuit	
Week 9 (5 Nov)	18. Module 2: Bioinstrumentation (2) – Bioelectric Phenomena (Part I)	Project topic selection with title and short abstract (Due date)

Week 10 (7 Nov)	19. Module 2: Bioinstrumentation (3) – Bioelectric Phenomena (Part II)	
Week 10 (12 Nov)	20. Module 2: Bioinstrumentation (4) – EEG, EMG, and EOG	Release of Homework 3; **Tutorial on 14 Nov
Week 11 (14 Nov)	21. Module 2: Bioinstrumentation (5) – Flow Cytometry	
Week 11 (19 Nov)	22. Module 2: Bioinstrumentation (6) – Blood Glucose Sensor	Homework 3 (<i>Due date</i>)
Week 12 (21 Nov)	23. Module 2: Bioinstrumentation (7) – Pulse Oximetry	
Week 12 (26 Nov)	24. Module 2: Bioinstrumentation (8) – DNA Microarray	Project report (<i>Due date</i>)
Week 13 (28 Nov)	25. Project presentation	In-class presentation; Project PowerPoint (<i>Due date</i>)
TBD		Release of take-home final examination