BIEN 3410 (3 Credits)

Bioimaging and Image Analysis

The Hong Kong University of Science and Technology

Course Syllabus

Teaching Team

Instructor:

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

Postgraduate teaching assistant (PG TAs):

- Mr. Ka Wai LAI (James), email: kwlaiak@connect.ust.hk
- Mr. Tsz Fung CHAN (Calvin), email: tfchanal@connect.ust.hk

Course Description

This course introduces various bioimaging methods and their data analysis approaches, including optical coherence tomography, fluorescence microscopy, nonlinear microscopy, super-resolution microscopy, and photoacoustic tomography. Students will be able to understand, design, and evaluate those imaging techniques. This course requires basic knowledge of linear algebra, calculus, and geometry.

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 imaging technologies
2. Design and evaluate imaging devices that can acquire biological information from the human body
3. Understand how bio/biomedical imaging technologies address clinical needs in practice

4. Perform calculations to evaluate the performance of bioimaging devices

Course Requirements

Lectures

Monday (1:30–2:50 pm, Room 5560, face-to-face) and Friday (9:00–10:20 am, Room 5560, 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 Tuesday, 6:00–6:50 pm (Room 5506, face-to-face), every time 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 up 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/vpaao/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)

Course AI Policy

The use of Generative AI in projects is permitted with proper acknowledgment and will NOT be contributed to the student's 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 for 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.

Please note that one of the weeks will be taught by PG TAs

Date	Topics *(tentative)*	Remarks
Week 1 (1 & 5 Sep)	01. Course Overview 02. What Is Bioimaging?	
Week 2 (8 & 12 Sep)	03. Geometrical (Ray) Optics (Part I) 04. Geometrical (Ray) Optics (Part II)	
Week 3 (15 & 19 Sep)	05. Optical Microscopy (Part I) 06. Optical Microscopy (Part II)	Release of Homework 1
Week 4 (22 & 26 Sep)	07. Phase Contrast Microscopy 08. Wave Optics	Homework 1 ***(Due date)***
Week 5 (29 Sep & 3 Oct)	09. Gaussian Beam Optics and Interference (Part I) 10. Gaussian Beam Optics and Interference (Part II)	
Week 6 (6 & 10 Oct)	11. Optical Coherence Tomography (Part I)	

	12. Optical Coherence Tomography (Part II)	
Week 7 (13 & 17 Oct)	13. Fluorescence Microscopy (Part I) 14. Fluorescence Microscopy (Part II)	Release of Homework 2
Week 8 (20 & 24 Oct)	15. Nonlinear Microscopy (Part I) 16. Nonlinear Microscopy (Part II)	Homework 2 ***(Due date)***
Week 9 (27 & 31 Oct)	17. Fiber Endoscopy 18. Bioimaging Research Sharing: Sharing by Postgraduate Students and Professor	Project topic selection with title and short abstract ***(Due date)***
Week 10 (3 & 7 Nov)	19. Photoacoustic Tomography (Part I) 20. Photoacoustic Tomography (Part II)	
Week 11 (10 & 14 Nov)	21. Flow Cytometry (Part I) 22. Flow Cytometry (Part II)	Release of Homework 3
Week 12 (17 & 21 Nov)	23. Fundamentals of Image Processing (Part I) 24. Fundamentals of Image Processing (Part II)	Homework 3 ***(Due date)***
Week 13 (24 & 28 Nov)	25. Project Presentation (Part I) 26. Project Presentation (Part II)	In-class presentation; Project report ***(Due date)***; Project PowerPoint ***(Due date)***
TBD	27. Final Examination	