

# **The Hong Kong University of Science and Technology**

## **UG Course Syllabus**

Bioimaging and Image Analysis

BIEN 3410

3 Credits

No prerequisite

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### **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.

Methods of instruction include lectures, student presentations, class discussions, and in-class exercises. Students are expected to actively participate in class discussions and activities.

### **Intended Learning Outcomes (ILOs)**

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.

### **Assessment and Grading**

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

**Assessments:**

| <b>Assessment Task</b>            | <b>Contribution to Overall Course grade (%)</b> | <b>Due date</b> |
|-----------------------------------|-------------------------------------------------|-----------------|
| Class Participation               | 10%                                             | Ongoing         |
| Homework (3 sets, 5% each)        | 15%                                             | ~Weeks 4, 8, 12 |
| Group Project – Report            | 15%                                             | Week 13         |
| Group Project – Oral Presentation | 20%                                             | Week 13         |
| Final examination                 | 40%                                             | TBD             |

\* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

**Mapping of Course ILOs to Assessment Tasks**

| <b>Assessed Task</b>              | <b>Mapped ILOs</b>     | <b>Explanation</b>                                                                                                                                                          |
|-----------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Class Participation               | ILO1, ILO3             | In-class Canvas quizzes assess students' ability to describe working principles of bioimaging technologies (ILO1) and understand how they address clinical needs (ILO3).    |
| Homework                          | ILO1, ILO4             | Homework assignments evaluate students' ability to describe imaging principles (ILO1) and perform calculations to evaluate device performance (ILO4).                       |
| Group Project – Report            | ILO1, ILO2, ILO3       | The report assesses students' ability to describe working principles (ILO1), design/evaluate imaging devices (ILO2), and understand clinical applications (ILO3).           |
| Group Project – Oral Presentation | ILO2, ILO3             | The presentation assesses students' ability to design/evaluate imaging devices (ILO2) and articulate how technologies address clinical needs (ILO3) in a compelling manner. |
| Final examination                 | ILO1, ILO2, ILO3, ILO4 | The final examination assesses comprehensive understanding of all ILOs, requiring students to integrate knowledge across all imaging modalities.                            |

## Grading Rubrics

### Homework Rubric

| Criteria                         | Excellent<br>(90–100%)    | Good<br>(75–89%)                                                                           | Satisfactory<br>(60–74%)                         | Marginal<br>(50–59%)                                      | Fail<br>(<50%)                      |
|----------------------------------|---------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------------------------------------------------|-------------------------------------|
| <b>Accuracy of Calculations</b>  | Accuracy of Calculations  | All calculations are correct with appropriate units and significant figures                | Most calculations are correct with minor errors  | Some calculations are correct; significant errors present | Few calculations are correct        |
| <b>Understanding of Concepts</b> | Understanding of Concepts | Demonstrates deep understanding of imaging principles and can apply them to novel problems | Demonstrates solid understanding with minor gaps | Demonstrates basic understanding but with notable gaps    | Demonstrates limited understanding  |
| <b>Clarity of Explanations</b>   | Clarity of Explanations   | Explanations are clear, concise, and well-organized                                        | Explanations are mostly clear with minor issues  | Explanations are somewhat unclear or disorganized         | Explanations are vague or confusing |

### Group Project Report Rubric

| Criteria                          | Excellent<br>(90–100%)                                                             | Good<br>(75–89%)                                    | Satisfactory<br>(60–74%)                             | Marginal<br>(50–59%)                     | Fail<br>(<50%)                            | Mapping<br>to Course<br>ILOs |
|-----------------------------------|------------------------------------------------------------------------------------|-----------------------------------------------------|------------------------------------------------------|------------------------------------------|-------------------------------------------|------------------------------|
| <b>Technology<br/>Description</b> | Comprehensive and accurate description of core technology with exceptional clarity | Clear and accurate description with minor omissions | Adequate description with some omissions             | Vague or incomplete description          | Technology not described or misunderstood | ILO1                         |
| <b>Problem<br/>Identification</b> | Problem is clearly defined, contextualized, and significant                        | Problem is defined with good context                | Problem is defined but lacks clarity or significance | Problem is vague or inaccurate           | Problem not defined                       | ILO3                         |
| <b>Competitor<br/>Analysis</b>    | Thorough analysis with meaningful comparisons                                      | Good analysis with relevant comparisons             | Basic analysis with some comparisons                 | Limited analysis with few comparisons    | No competitor analysis                    | ILO2, ILO3                   |
| <b>Overall Quality</b>            | Well-organized, concise, and free of errors                                        | Mostly organized and clear with few errors          | Somewhat disorganized with some errors               | Poorly organized with significant errors | Incomplete or not submitted               | All ILOs                     |

### Group Project Oral Presentation Rubric

| Criteria                     | Excellent<br>(90–100%)                                                               | Good<br>(75–89%)                         | Satisfactory<br>(60–74%)                      | Marginal<br>(50–59%)                      | Fail<br>(<50%)                      | Mapping<br>to Course<br>ILOs |
|------------------------------|--------------------------------------------------------------------------------------|------------------------------------------|-----------------------------------------------|-------------------------------------------|-------------------------------------|------------------------------|
| <b>Content &amp; Clarity</b> | Exceptional explanation of technology, problem, and impact with compelling narrative | Clear explanation with good narrative    | Adequate explanation with some clarity issues | Unclear explanation with poor narrative   | Content incomprehensible or missing | ILO2, ILO3                   |
| <b>Presentation Skills</b>   | Confident delivery, excellent eye contact, and effective use of visual aids          | Good delivery with effective visual aids | Adequate delivery with some issues            | Poor delivery with distracting elements   | Ineffective presentation            | All ILOs                     |
| <b>Q&amp;A Response</b>      | Exceptional responses demonstrating deep understanding                               | Good responses with minor gaps           | Adequate responses with some gaps             | Poor responses with limited understanding | Unable to answer questions          | ILO1, ILO2, ILO3             |
| <b>Time Management</b>       | Presentation within time limit with perfect pacing                                   | Within time limit with good pacing       | Slightly over/under time                      | Significant time management issues        | Incomplete presentation             | All ILOs                     |

**Final Grade Descriptors:**

| Grades | Short Description        | Elaboration on subject grading description                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A      | Excellent Performance    | Demonstrates a comprehensive grasp of bioimaging principles, including advanced understanding of optical coherence tomography, fluorescence microscopy, nonlinear microscopy, super-resolution microscopy, and photoacoustic tomography. Exhibits expertise in designing and evaluating imaging devices with significant creativity in problem-solving. Shows exceptional ability to connect imaging technologies to clinical applications and performs calculations with high accuracy. |
| B      | Good Performance         | Shows good knowledge and understanding of core bioimaging technologies and their working principles. Demonstrates competence in evaluating imaging device performance and the ability to analyze clinical applications. Displays strong quantitative skills in performing calculations and good collaboration in group project work.                                                                                                                                                     |
| C      | Satisfactory Performance | Possesses adequate knowledge of fundamental bioimaging methods and can describe their basic working principles. Demonstrates competence in performing standard calculations and some capacity for device evaluation. Shows persistence in achieving learning goals and satisfactory participation in group work.                                                                                                                                                                         |
| D      | Marginal Pass            | Has threshold knowledge of core bioimaging technologies with potential to apply key skills. Can make basic judgments about imaging applications and demonstrates the ability to perform basic calculations. Benefits from the course and shows potential for further development in the discipline.                                                                                                                                                                                      |
| F      | Fail                     | Demonstrates insufficient understanding of bioimaging principles and lacks necessary quantitative skills. Shows limited ability to describe or evaluate imaging technologies or connect them to clinical needs. Does not meet the threshold requirements for professional practice or development in the discipline.                                                                                                                                                                     |

**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. Students must clearly indicate which parts of their work were generated or assisted by AI tools and provide appropriate citations.

**Communication and Feedback**

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include comments on strengths and areas for improvement. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

## **Resubmission Policy**

Graded homework submitted after the deadline will receive no credit. No exceptions. Late submissions will not be accepted.

## **Suggested Texts and Materials**

1. "Introduction to Biophotonics," Paras N. Prasad, Wiley (2003)
2. "Understanding Biophotonics: Fundamentals, Advances, and Applications," Kevin Tsia, Jenny Stanford Publishing (2015)

## **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.