

BME8131: BIOMEDICAL IMAGING AND BIOPHOTONICS

Effective Term

Semester B 2024/25

Part I Course Overview

Course Title

Biomedical Imaging and Biophotonics

Subject Code

BME - Biomedical Engineering

Course Number

8131

Academic Unit

Biomedical Engineering (BME)

College/School

College of Biomedicine (BD)

Course Duration

One Semester

Credit Units

3

Level

R8 - Research Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

Nil

Equivalent Courses

MBE6118/BME6118 Biomedical Imaging and Biophotonics

Exclusive Courses

Nil

Part II Course Details

Abstract

This aim of this course is to develop students' knowledge and understanding about the fundamental principles of medical imaging technologies and biophotonics, and their applications to real-world devices. The topical coverage includes magnetic resonance imaging, x-ray computed tomography, ultrasonography, optical scattering theory and modelling, optical sensing and spectroscopy, optical microscopy, and photoacoustic tomography. Following the completion of this course, students will have a good understanding of various methods and instruments used in biomedical optical research and clinical applications.

Course Intended Learning Outcomes (CILOs)

CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the concepts and principles of major medical imaging technologies.		x	
2	Employ concepts of photon-tissue interaction in biological tissues.		x	
3	Explain principles of optical sensing, spectroscopy, and imaging techniques.	x	x	
4	Interpret the principles of major imaging and their techniques, select proper imaging techniques for different biomedical imaging applications.		x	
5	Discuss medical and biological photoacoustic imaging for biomedical applications technologies to clinical or preclinical problems.	x	x	x

A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

LTAs	Brief Description	CILO No.	Hours/week (if applicable)	
1	Lectures/Tutorial	Explain key concepts and mathematical models related to medical and optical imaging and sensing technologies.	1, 2, 3, 4	3 hrs/week
2	Homework/ Examination	Require students to solve the problems based on the theories and models discussed during lectures.	1, 2, 3, 4, 5	N.A.

3	Project	Require students to propose an improvement or a new design of an optical imaging technology through literature survey	1, 3, 4, 5	N.A.
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Assessment Tasks / Activities (ATs)

ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Project	1, 3, 4, 5	20
2	Assignments	1, 2, 3, 4, 5	20

Continuous Assessment (%)

40

Examination (%)

60

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

0

Minimum Examination Passing Requirement (%)

0

Assessment Rubrics (AR)**Assessment Task**

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

1.1 Ability to analyze problems in medical imaging and biophotonics, 1.2 Ability to apply principles to solve biomedical problems.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Project (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to acquire knowledge related to a medical imaging or biophotonic technique, identify a problem, and propose a methodology to solve the problem.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Assignment (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to solve problems relevant to medical imaging, optical sensing, spectroscopy, and imaging.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

1.1 Ability to analyze problems in medical imaging and biophotonics, 1.2 Ability to apply principles to solve biomedical problems.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Project (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to acquire knowledge related to a medical imaging or biophotonic technique, identify a problem, and propose a methodology to solve the problem.

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Assessment Task

Assignment (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to solve problems relevant to medical imaging, optical sensing, spectroscopy, and imaging.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

In-class test (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Describe the principles of biomechanics and mechanical design concepts to provide solutions to related problems.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Group-project report and presentation (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to identify problems and propose methods in analysing/solving biomechanics related problems in real life.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Explain the fundamental concepts and working principles of biomechanics and design, select proper machine elements and solve problems.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

In-class test (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Describe the principles of biomechanics and mechanical design concepts to provide solutions to related problems.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

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(B-, C+, C) Basic

Failure

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Assessment Task

Group-project report and presentation (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to identify problems and propose methods in analysing/solving biomechanics related problems in real life.

Excellent

(A+, A, A-) High

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(B+, B) Significant

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(B-, C+, C) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Explain the fundamental concepts and working principles of biomechanics and design, select proper machine elements and solve problems.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

Magnetic resonant imaging, X-ray computed tomography, Ultrasonography, Tissue-photon interaction, Optical sensing and spectroscopy Optical microscopy Optical coherence tomography and Photoacoustic imaging.

Reading List

Compulsory Readings

Title	
1	Biomedical optics: principles and imaging. Wang, Lihong V., and Hsin-I. Wu. 2012.
2	Fundamentals of Medical Imaging. Suetens, Paul, 2009

Additional Readings

Title	
1	Fundamentals of Photonics, 2nd Edition. Bahaa E. A. Saleh, Malvin Carl Teich. 2007
2	P. N. Prasad, "Introduction to biophotonics", John Wiley & Sons, Inc., New Jersey, 2003.
3	Markolf H. Niemz, "Laser-Tissue Interactions", Springer, Berlin, 2007.