BME8140: ADVANCED OPTICAL MICROSCOPY FOR BIOMEDICAL ENGINEERING

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Advanced Optical Microscopy for Biomedical Engineering

Subject Code
BME - Biomedical Engineering
Course Number
8140

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
BME6140 Advanced Optical Microscopy for Biomedical Engineering

Exclusive Courses
Nil

Part II Course Details

Abstract

This course will provide students with a comprehensive overview of optical microscopy and various imaging technologies including the latest advances. The course will start with basic concepts in optics explaining how light-matter interactions generate contrast for imaging and cover practical basics in optical microscopy.

The course will then cover various optical microscopy modalities: widefield, structured illumination, confocal, multiphoton, and light sheet microscopies. The course will also introduce other advanced imaging techniques including adaptive optics label-free microscopy, and super-resolution imaging methods. In addition, the course will introduce recent advances in how artificial intelligence (AI) is applied in optical imaging. Upon completion of this course, students will become familiar with all the available options and develop the ability to choose the right tool for their future studies.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Understand basic concepts in optics, different contrast mechanisms and practical basics in optical microscopy.		x	x	
2	Understand the principles of various imaging modalities and advanced imaging techniques.		x	x	
3	Understand how AI is applied for optical biomedical imaging.		x	x	
4	Evaluate current literature and present scientific written and oral reports on relevant topics.		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	Lecture	Explain concepts and principles of optical imaging	1, 2, 3, 4	2 hrs/week
2	Tutorial / Quiz	Solve problems based on concepts discussed during lectures	1, 2, 3, 4	1 hr/week
3	Mini-project	Prepare oral and written proposals on topic of choice through literature review.	2, 3, 4	N.A.

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Assignments & Quizzes	1, 2, 3, 4	25	Assignments & Quizzes based on course modules discussed during the lectures	No
2	Individual term project (report + presentation)	1, 2, 3, 4	35	Individual term project based on written report and/or oral presentation. The project will focus on review of a student-selected imaging technology and its biomedical applications	No

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

Final exam at the end of semester on questions based on coursework discussed in the lectures

Assessment Rubrics (AR)

Assessment Task

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

Criterion

Ability to describe in detail concepts in optics and optical microscopy, principles of different imaging modalities / techniques, and their advantages & limitations.

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
Capacity for self-directed learning; quality of literature review; ability to critically assess the topic; quality of scientific presentation: written and oral.

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
Ability to describe in detail concepts in optics and optical microscopy, principles of different imaging modalities / techniques, and their advantages & limitations Ability to choose the most suitable tool for a specific study.

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 from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to describe in detail concepts in optics and optical microscopy, principles of different imaging modalities / techniques, and their advantages & limitations.

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

Capacity for self-directed learning; quality of literature review; ability to critically assess the topic; quality of scientific presentation: written and oral.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(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

Ability to describe in detail concepts in optics and optical microscopy, principles of different imaging modalities / techniques, and their advantages & limitations Ability to choose the most suitable tool for a specific study.

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

Optical microscopy, Fluorescence microscopy, Label-free imaging, High-resolution imaging, Super-resolution imaging, AI in optical imaging

Reading List

Compulsory Readings

	Title
1	Fundamentals of Light Microscopy and Electronic Imaging 2nd Edition, Douglas B. Murphy, Michael W. Davidson,
2	Introduction to Optical Microscopy, Jerome Mertz
3	Scientific articles

Additional Readings

	Title
1	Introduction to Fourier Optics, Joseph W. Goodman
2	Introduction to Biophotonics, Paras N. Prasad