MSE6181: PHOTONICS IN NANOMATERIAL SYSTEMS AND DEVICES

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Photonics in Nanomaterial Systems and Devices

Subject Code
MSE - Materials Science and Engineering
Course Number
6181

Academic Unit
Materials Science and Engineering (MSE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
AP6181 Photonics in Nanomaterial Systems and Devices (From the old curriculum)

Exclusive Courses
AP8181 Photonics in Nanomaterial Systems and Devices (From the old curriculum)

Part II Course Details

Abstract

To use the principles of physical optics and light-matter interaction to study the optical properties of materials and optical devices. To explore and discuss applications of the course's topics in science and technology and to explore the principles and applications of nano-optics and nano-photonics.

Upon successful completion of the course, students are expected to be equipped with sufficient knowledge to discuss the different techniques used to study the interaction of light with mater, to explain the propagation of light in different media as it relates to propagation, absorption, and emission processes, and to develop a working knowledge in the application of selected photonic and optical material systems and devices.

The students will be able to rationalize and explain the applications of the course contents to modern practical scientific and technological applications with emphasis in nanomaterials and nanotechnology.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Identify the physical principles involved in optical systems.	25	x		
2	Describe the phenomena that occur during the propagation of light and the basic models that explain it.	25		x	
3	Use the principles of light-matter interactions and describe its applications and importance.	25	x	x	x
4	Explain the key properties and working principles of typical photonic devices	25	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	Students will engage in formal lectures to gain knowledge about optics and their applications in nanomaterials and nanophotonics.	1, 2, 3, 4	25 hrs
2	Tutorials	Students will engage in tutorial activities to extend the application of optical principles in solving practical problems.	1, 2, 3, 4	5 hrs

3	Presentation	Students will engage in discussion on the optical phenomenon to strength their knowledge and skills.	3, 4	9 hrs

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Assignments	1, 2, 3, 4	30	-	No
2	Presentation	1, 2, 3, 4	20	-	Yes

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Assessment Rubrics (AR)

Assessment Task

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

Criterion

Able to describe basic principles and apply them to solve fundamental 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 level

Assessment Task

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

Criterion

Ability to select a project, design a protocol to address it, and advance its resolution. Demonstrate a curiosity driven approach to self-study and capacity to understand and explain new concepts.

Excellent

(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal level

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

Criterion
Knowledge of the fundamental course contents including concepts of ray, wave, near-field optics, and light-matter interaction, and their use for the characterization of materials and design of device applications.

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal level

Assessment Task
Assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Able to describe basic principles and apply them to solve fundamental problems

Excellent
(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal level

Assessment Task

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

Criterion

Ability to select a project, design a protocol to address it, and advance its resolution. Demonstrate a curiosity driven approach to self-study and capacity to understand and explain new concepts.

Excellent

(A+, A, A-) High

Good

(B+, B) Moderate

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal level

Assessment Task

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

Criterion

Knowledge of the fundamental course contents including concepts of ray, wave, near-field optics, and light-matter interaction, and their use for the characterization of materials and design of device applications.

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Good

(B+, B) Moderate

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal level

Part III Other Information

Keyword Syllabus

- Evolution of nature of light and key phenomenon, experiments, and theories: Newton’ s rings, double-slit experiment, Poisson’ s spot, Maxwell equations, Planck's Quantum Theory, De Broglie hypothesis.
- Models and principles of geometrical optics, wave optics, and quantum optics: basic equations and concepts including reflection, refraction, interference, diffraction, coherence, polarization, light-material interactions.
- Propagation of light: Huygens’ and Fermat’ s principle, speed of light, refractive index, Fresnel equations.
- Absorption and emission of light: photoelectric effect, spontaneous emission, radiationless emission, stimulated emission, population inversion.

- Principles and applications of modern nano-photonic devices: light sources (e.g., lamps, lasers, LEDs), photodetectors, waveguides and optical fibers, including their types, components, light-matter interaction, working principles, characteristics, and practical applications.

Reading List

Compulsory Readings

	Title
1	Optics, 4th edition, Eugene Hecht, Addison Wesley 2002.
2	Introduction to Optics, 3rd edition, Frank L. Pedrotti, S.J., Leno M. Pedrotti, Leno S. Pedrotti
3	Optoelectronic and Photonics: Principles and Practices, S O Kasap, Prentice Hall, 2001.
4	Fundamentals of Photonics, Bahaa E. A. Saleh, Malvin Carl Teich, John Wiley & Sons, Inc.

Additional Readings

	Title
1	L Novotny and B Hetch, Principles of nano-optics Cambridge University Press, 2006
2	Motoichi Ohtsu [et al.] Principles of nanophotonics CRC Press/Taylor & Francis,
3	M Ohtsu (Eds.) Nanophotonics and nanofabrication Weinheim : Wiley-VCH, c2009.
4	Baldassare Di Bartolo and John Collins (Eds.), Biophotonics: spectroscopy, imaging, sensing, and manipulation.