EE5436: FUNDAMENTALS AND APPLICATIONS OF PHOTONICS

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Fundamentals and Applications of Photonics

Subject Code
EE - Electrical Engineering
Course Number
5436

Academic Unit
Electrical Engineering (EE)

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
EE2104 Introduction to Electromagnetics

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

The course aims to help the student to learn the basic principles of photonics technology, the most popular optical devices and their applications in optical communication, next generation microprocessor and biomedical sensing.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain the fundamental principles of photonic technology.		x		
2	Apply electromagnetic theories to understand the working principles of photonic components.		x		
3	Independently design photonic devices for specific tasks.		x	x	
4	Identify and explain the applications of different photonic devices.		x	x	
5	Perform independent studies to identify future developments of photonic technologies.		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	Learn and understand the fundamental theories, important concepts and major applications of photonic devices.	1, 2, 3, 4	2 hrs/wk (for 11 weeks)
2	Tutorial	Work out important concepts based on problems and discussions	1, 2, 3, 4	1 hr/wk (for 11 weeks)
3	Project	Research selected photonic technology topics and provide independent evaluations.	3, 4, 5	3 hr/wk (for 2 weeks)

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Tests (min.: 1)	1, 2, 3, 4	25	-	No
2	#Assignments (min.: 3)	1, 2, 3, 4	10	-	Yes
3	Project	1, 2, 3, 4, 5	15	-	Yes

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

Remark: To pass the course, students are required to achieve at least 30% in course work and 30% in the examination. # may include homework, tutorial exercise, project/mini-project, presentation

Assessment Rubrics (AR)

Assessment Task

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

Criterion

Achievements in CILOs

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

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

Criterion

Achievements in CILOs

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 from Semester A 2022/23 to Summer Term 2024)

Criterion
Achievements in CILOs

Excellent
(A+, A, A-) High

Good
(B+, B) Medium

Marginal
(B-, C+, C) Low

Failure
(F) Not even reaching marginal level

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

Criterion
Achievements in CILOs

Excellent
(A+, A, A-) High

Good
(B+, B) Medium

Marginal
(B-, C+, C) Low

Failure
(F) Not even reaching marginal level

Additional Information for AR

Constructive Alignment with Programme Outcomes

PILO 1, 2, 3 - Students are required to apply the fundamental theoretical knowledge and analytical skills for an in-depth understanding of the working principles and applications of photonic technologies.
PILO 4 - Students are required to complete an independent research study on new developments of photonic technologies.
PILO 6 - Students are required to give an oral presentation of their independent research studies.

Part III Other Information

Keyword Syllabus

Ray Optics
- Basic concepts of ray optics: refraction, reflection, Snell's law, total internal reflection
- Basic optical components: mirrors, prisms, lenses
- Transfer matrix method

Wave and Beam Optics
- Electromagnetic theory of light
- Polarization states of light
- Absorption, dispersion, phase and group velocity
- Gaussian beam, beam shaping components

Guided-Wave Optics
- Planar mirror waveguides
- Planar dielectric waveguides, 2D dielectric waveguides, effective index theory
- Coupled-mode theory

Integrated Photonics
- Basic integrated photonic waveguides: rib, ridge waveguides
- Arrayed-waveguide gratings, Mach-Zehnder interferometers, waveguide tapers

Resonator Optics
- Fabry-Perot resonators
- Microring resonators, microring-based filters

Nonlinear Optics & Electro-Optics
- Basic principles and concepts of nonlinear optics
- Theory of second harmonic generation
- Theory and applications of electro-optic modulation

Reading List

Compulsory Readings

	Title
1	B. E. A. Saleh and M. C. Teich Fundamentals of Photonics Wiley 1990

Additional Readings

	Title
1	A. Yariv and P. Yeh Photonics: Optical Electronics in Modern Communications 6th Edition, Oxford University Press, 2007.
2	L. Novotny and B. Hecht Principles of Nano-Optics Cambridge University Press, 2012.