# EE4142: INTRODUCTION TO INTEGRATED PHOTONICS

**Effective Term**
Semester A 2025/26

## Part I Course Overview

**Course Title**
Introduction to Integrated Photonics

**Subject Code**
EE - Electrical Engineering
**Course Number**
4142

**Academic Unit**
Electrical Engineering (EE)

**College/School**
College of Engineering (EG)

**Course Duration**
One Semester

**Credit Units**
3

**Level**
B1, B2, B3, B4 - Bachelor's Degree

**Medium of Instruction**
English

**Medium of Assessment**
English

**Prerequisites**
EE2104 Introduction to Electromagnetics

**Precursors**
EE3109 Applied Electromagnetics

**Equivalent Courses**
Nil

**Exclusive Courses**
Nil

## Part II Course Details

**Abstract**

In the course, student will learn, understand and appreciate the principles of photonic technology. Light-based technology is efficient, reliable, and fast. However, the components used are typically discrete and physically separate from one another, and need to be connected together by various coupling means to create a complete system or sub-system.
Similar to integrated electronics (microelectronics), which has revolutionized the field of electronics by enabling the integration of numerous electronic components onto a single semiconductor chip, integrated photonics seeks to achieve similar advancements using light instead of electrons. The integration of various photonic components, such as lasers, waveguides, modulators, and detectors, onto a single chip or substrate, has many advantages. For example, by combining the advantages of silicon photonics and CMOS circuits, high bandwidth data can be moved throughout the entire data network using significantly less power.

**Course Intended Learning Outcomes (CILOs)**

| | CILOs | Weighting (if app.) | DEC-A1 | DEC-A2 | DEC-A3 |
|---|---|---|---|---|---|
| 1 | Explain the fundamental operating principles of integrated photonic device and technology. | | x | x | |
| 2 | Identify and describe the applications of different integrated photonic devices. | | x | x | |
| 3 | Apply the basic optical theories to design simple integrated photonic devices. | | x | x | |
| 4 | Design system/subsystem using integrated photonic devices. | | x | x | x |
| 5 | Operate some commonly used integrated photonic devices. | | | 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 | Students will engage in lecture activities about basic concepts of integrated photonic device and technology. | 1, 2, 3, 4 | 3 hrs/wk |
| 2 | Laboratory | Students will engage in laboratory activities about principles and operations of integrated photonic device and technology. | 1, 2, 3, 4, 5 | 3 hrs/wk (for 2 weeks) |

| | | | | |
|---|---|---|---|---|
| 3 | Individual assignment | Important concepts are worked out based on problems and discussions. | 1, 2, 3, 4 | |

**Assessment Tasks / Activities (ATs)**

| | ATs | CILO No. | Weighting (%) | Remarks ("-" for nil entry) | Allow Use of GenAI? |
|---|---|---|---|---|---|
| 1 | Tests (min.: 2) | 1, 2, 3, 4 | 30 | | |
| 2 | #Assignments (min.: 3) | 1, 2, 3, 4 | 10 | | |
| 3 | Lab Exercises/ Reports | 1, 2, 3, 4, 5 | 10 | | |

**Continuous Assessment (%)**

50

**Examination (%)**

50

**Examination Duration (Hours)**

2

**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. Also, 75% laboratory attendance rate must be obtained. # may include homework, tutorial exercise, project/mini-project, presentation

**Assessment Rubrics (AR)**

**Assessment Task**

Tests and Examination

**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 levels

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**Assessment Task**

Assignments

**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 levels

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**Assessment Task**
Laboratory report

**Criterion**
Achievements in CILOs

**Excellent (A+, A, A-)**
High

**Good (B+, B, B-)**
Significant

**Fair (C+, C, C-)**
Moderate

**Marginal (D)**
Basic

**Failure (F)**
Below marginal level

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# Part III Other Information

**Keyword Syllabus**

Introduction
Integrated Photonics: history and motivation.

Theory of Optical Waveguides
Basic analysis of planar waveguides and channel waveguides. Optical waveguide modes. Numerical analysis.

Fabrication and Characterization of Optical Waveguides
Fabrication techniques. Waveguide input and output couplers. Characterization and measurements.

Passive Photonic Waveguide Devices

Coupled mode theory. Passive devices: Directional coupler waveguides; Grating waveguides; Tapered waveguides; Y-junction waveguides; Mach-Zehnder interferometer waveguides; Wavelength-division multiplexing devices.

Active Photonic Waveguide Devices
Physical effects: electro-optic, acousto-optic and magneto-optic effects. Active devices: Waveguide modulators and switches.

Optoelectronic Devices
Semiconductor lasers and detectors. Monolithic integration.

Applications and Trends

**Reading List**

**Compulsory Readings**

| | Title |
|---|---|
| 1 | Nil |

**Additional Readings**

| | Title |
|---|---|
| 1 | T. Tamir, Integrated Optics, Springer-Verlag, 1975. |
| 2 | R. G. Hunsperger, Integrated Optics: Theory and Applications, 5th Edition, Springer-Verlag, Berlin Germany, 2002. |
| 3 | W. S. Chang, Fundamentals of Guided-Wave Optoelectronic Devices, Cambridge University Press, 2010. |
| 4 | K. Okamoto, Fundamentals of Optical Waveguides, 2nd Ed., Academic Press, 2006 |