DISCIPLINE SPECIFIC CORE COURSE – 17: Photonics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Photonics	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Electro-magnetics (DSC 14, Sem V)**

Learning Objectives

The Learning Objectives of this course are as follows:

- This course introduces the student to the fundamental understanding of light as an electromagnetic wave and various phenomenon like interference, diffraction and polarization and their applications.
- Interaction between a photon and electron and its relevance to laser and various other optoelectronic devices.
- Understand the propagation of wave in planar optical waveguides and optical fibers.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Describe the optics and simple optical systems.
- Understand the concept of light as a wave and its propagation in optical fibres, and relevance of this to optical effects such as interference , diffraction, polarization and hence to lasers, holography and optical waveguides.
- Use mathematical methods to predict optical effects with e.g. light-matter interaction, wave propagation in guided media, dispersion, wave optics

SYLLABUS OF ELDSC-17 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Light as an Electromagnetic Wave: Plane waves in homogeneous media, concept of spherical waves. Reflection and transmission at an interface, total internal reflection, Brewster's Law.
Interference : Interference by division of wavefront, Young's double slit, Division of Amplitude, thin film interference, anti-reflecting films, Newton's rings.
Diffraction: Fraunhoffer Diffraction by a single slit, double slit, Diffraction grating: Resolving power and Dispersive power

UNIT – II (11 Hours)
Holography: Basic Principle , Construction and reconstruction of hologram.
Polarization: Linear, circular and elliptical polarization, polarizer-analyzer and Malus' law; Double refraction by crystals, Half wave and quarter wave plates. Electro optic Effect, Faraday Rotation
Liquid Crystal Displays: Types, Working Principle.

UNIT – III (11 Hours)
Light Emitting Diodes: Construction, materials and operation.
Lasers: Interaction of radiation and matter, Einstein coefficients, Condition for amplification, Laser cavity , Examples of common lasers. The semiconductor injection laser diode.
Photodetectors: Photo transistors and Photodiodes (p-i-n, avalanche), quantum efficiency and responsivity.

UNIT – IV (11 Hours)
Guided Waves and the Optical Fibre: Maxwell's Equations, TE modes in symmetric step index planar slab waveguides, effective index, field distributions, Step index optical fibre, total internal reflection, single mode and multimode fibres, attenuation and dispersion in optical fibres.

Practical component (if any) – Photonics
(Hardware Lab augmented with virtual lab)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform experiments based on the phenomenon of light/photons.
- Measure the parameters such as wavelength, resolving power, numerical aperture etc. using the appropriate photonic/optical technique.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To determine Brewster's angle.
2. To determine wavelength of sodium light using Newton's Rings.
3. To determine the resolving power and Dispersive power of Diffraction Grating.
4. Diffraction experiments using a laser.

5. Viewing of different types of holograms.
6. To verify the law of Malus for plane polarized light.
7. Study of Faraday Rotation.
8. Study of Electro-optic Effect.
9. To determine characteristics of LEDs and Photo- detector.
10. To measure the numerical aperture of an optical fiber.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

In addition to the above hardware lab , teaching learning process can be further augmented using following/any other ONLINE virtual labs:

- Amrita Vishwa Vidyapeetham Virtual Lab https://vlab.amrita.edu/
- Virtual Labs ofcvlab.vesit.ves.ac.in

Essential/recommended readings

1. Ajoy Ghatak, Optics, Tata McGraw Hill, New Delhi (2005)
2. E. Hecht, Optics, Pearson Education Ltd. (2002)
3. Ghatak A.K. and Thyagarajan K., —Introduction to fiber optics, Cambridge Univ. Press. (1998)

Suggestive readings

1. J. Wilson and J. F. B. Hawkes, Optoelectronics: An Introduction, Prentice Hall India (1996)
2. S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson Education (2009)

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.