B.Sc. Physical Sciences with Physics as one of the Core Disciplines

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 8-1 : APPLIED OPTICS

Course Title and Code	Credits	Credit distribution of the course			Pre-requisite of the course
		Lecture	Tutorial	Practical	
Applied Optics DSE 8-1	4	2	0	2	

COURSE OBJECTIVES

This paper provides the conceptual understanding of various branches of modern optics to the students. This course introduces basic principles of LASER, Holography and signal transmission via optical fiber.

LEARNING OUTCOMES

At the end of this course, students will be able to

- Understand basic lasing mechanism qualitatively, types of lasers, characteristics of laser light and its application in developing LED, Holography.
- Gain concepts of Fourier optics and Fourier transform spectroscopy.
- Understand basic principle and theory of Holography.
- Grasp the idea of total internal reflection and learn the characteristics of optical fibers.

SYLLABUS OF DSE 8-1
THEORY COMPONENT
(Hours: 30)

Unit I **(8 Hours)**

Photo-sources and Detectors Lasers
Absorption process, Spontaneous and stimulated emission processes, Theory of laser action, Population of energy levels, Einstein's coefficients and optical amplification, properties of laser beam, Ruby laser, He-Ne laser and semiconductor lasers. Light Emitting Diode (LED) and photo-detectors.

Unit II **(7 Hours)**

Fourier Optics

Fourier Optics and Fourier Transform Spectroscopy (Qualitative explanation). Concept of Spatial frequency filtering, Fourier transforming property of a thin lens, Fourier Transform Spectroscopy (FTS): measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry, and forensic science.

Unit III

Holography Introduction **(7 Hours)**

Basic principle and theory: recording and reconstruction processes, Requirements of holography-coherence, etc. Types of holograms: The thick or volume hologram, Multiplex hologram, white light reflection hologram; application of holography in microscopy, interferometry, and character recognition.

Unit IV **(8 Hours)**

Photonics

Optical fibres: Total Internal Reflection, Basic characteristics of the optical fibre: Principle of light propagation through a fibre, the coherent bundle, The numerical aperture, Attenuation in optical fibre and attenuation limit; Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating.

PRACTICAL COMPONENT: APPLIED OPTICS

(Hours: 60)

College to set up at least 10 experiments from the listed experiments. *At least 6 experiments to be performed by students from amongst the experiments offered.*

Experiments on Lasers

1. To determine the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid-state laser.
2. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid-state laser.
3. To find the polarization angle of laser light using polarizer and analyzer,
4. Thermal expansion of quartz using laser
5. To determine the wavelength and angular spread of laser light by using plane diffraction grating.

Experiments on Semiconductor Sources and Detectors

1. V-I characteristics of LED.
2. Study the characteristics of solid state laser.
3. Study the characteristics of LDR.
4. Characteristics of Photovoltaic Cell/ Photodiode.
5. Characteristics of IR sensor.

Experiments on Fourier Optics

1. Optical image addition/subtraction.
2. Optical image differentiation.
3. Fourier optical filtering.
4. Construction of an optical 4f system

Experiment on Fourier Transform Spectroscopy

To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done.

Experiments on Holography and interferometry

1. Recording and reconstruction of holograms (Computer simulation can also be done).
2. To construct a Michelson interferometer or a Fabry Perot interferometer.
3. To determine the wavelength of sodium light by using Michelson's interferometer.
4. To measure the refractive index of air.

Experiments on Fibre Optics

1. To measure the numerical aperture of an optical fibre
2. To measure the near field intensity profile of a fibre and study its refractive index profile
3. To study the variation of the bending loss in a multimode fibre
4. To determine the power loss at a splice between two multimode fibre
5. To determine the mode field diameter (MFD) of fundamental mode in a single mode fibre by measurements of its far field Gaussian pattern

REFERENCES

1. Introduction to Fourier Optics, Joseph W. Goodman, The McGraw- Hill, 1996.
2. Introduction to Fiber Optics, A. Ghatak & K. Thyagarajan, Cambridge University Press.
3. Fibre optics through experiments, M. R. Shenoy, S. K. Khijwania, et.al. 2009, Viva Books
4. Optical Electronics, Ajoy Ghatak and K. Thyagarajan, 2011, Cambridge University Press
5. Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.