[This question paper contains 4 printed pages.]

Your Roll No. 16035558003

Sr. No. of Question Paper : 2219 **IC**

Unique Paper Code : 32511603

Name of the Paper : Photonics

Name of the Course : **B.Sc. (H) Electronics**

Semester : VI

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. Question No. **1** is compulsory.
4. Use of Scientific calculator is allowed.

1. (a) A transmission grating has 5000 elements per cm. If the slits are 1×10^{-4} cm wide, will there be any missing orders? If so, identify it.

(b) Define Law of Malus.

(c) In Michelson interferometer 200 fringes cross the field of view when the movable mirror is moved through 0.0589 mm. Find the wavelength of the light used.

P.T.O.

(d) What is total internal reflection phenomenon? Discuss its application.

(e) Differentiate between step index fiber and graded index fiber. (3×5)

2. (a) Calculate the Fraunhofer diffraction pattern produced by a double slit arrangement with slit widths 'a' and with their centres separated by a distance 'b'. (6)

(b) Consider an electromagnetic plane wave in vacuum whose electric field is given by

$E_x = 10^2 \sin\{\pi(3\times10^6 Z - 9\times10^{14}t)\}$ v/m, $Ey = E_z = 0$.

Determine the following :

Speed, Frequency, wavelength, Intensity, Polarization. (5)

(c) In Young's double hole experiment using light of $\lambda = 0.5$ μm if a mica sheet ($n = 1.5$ μm) is introduced in front of one of the holes, the central fringe occupies the position originally occupied by the eleventh bright fringe. Obtain the thickness of the mica sheet. (4)

3. (a) In a uniaxial crystal, light is incident normally on it for optic axis lying in the plane of incidence and inclined to the refracting surface. Explain the phenomenon of double refraction for it. (7)

(b) Define and explain Brewster's Law. (4)

(c) A left circularly polarized beam ($\lambda = 0.5893$ μm) is incident normally on a calcite crystal (with its optic axis cut parallel to the surface) of thickness 0.005141 mm. What will be the state of polarization of the emergent beam?

$n_0 = 1.65836$, $n_e = 1.48641$ (4)

4. (a) Describe the working of semiconductor injection LASER diode. (5)

(b) Calculate the mirror reflectances in LASER cavity 10 cm long if threshold gain coefficient is 0.01/cm (Assume no other losses and index = 1.0) (5)

(c) What is a photodiode. Give the advantages of phototransistor over photodiode. (5)

5. (a) Consider a symmetric slab waveguide defined by the refractive index variation

$$n = n_1 \text{ for } |x| < d$$

$$= x_2 \text{ for } |x| > d$$

Derive the eigen value equation for the TM modes. (8)

(b) Define Numerical aperture of an optical fiber. On what factors the information carrying capacity of the fiber optic communication system depends. Also explain for a silica fiber, how the loss of the output power depends on wavelength. (7)

6. (a) Define Holography. Derive an expression explaining the formation of virtual image and real image of an object. (8)

(b) A soap film of refractive index 4/3 and of thickness 2.5×10^{-4} cm is illuminated by white light at an angle of 45°. The light reflected by it is examined spectroscopically in which it is found that dark band corresponds to a wavelength of 5×10^{-5} cm. Calculate the order of the dark band. (4)

(c) Define Dispersive power of a grating. (3)

7. Write short note on any **two** : (7.5×2)

(a) Michelson Interferometer

(b) Quantum efficiency and Responsivity

(c) Resolving Power of Microscope