[This question paper contains 4 printed pages.]

Sr. No. of Question Paper : 1818 **C** **Roll No.....**

Unique Paper Code : 251604

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

Name of the Paper : ELHT 603 : Optics and Optical 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. Each question is of **15** marks.

1. Attempt any **five** parts :

   (a) A thin film of MgF_2 is deposited over a glass lens (n=1.5) to reduce the losses due to reflection in the air (n = 1). Find the thickness of MgF_2 for $\lambda = 0.5$ μm for minimum reflection losses. Also what should be the refractive index of coated film of MgF_2?

   (b) In Young's double slit experiment, the two pin holes (virtual sources) are separated from each other by 0.02 cm. Their distance from the screen is 50 cm. Find the fringe width for $\lambda = 0.5$ μm.

   (c) Draw the intensity variation associated with diffraction by a circular aperture. What is this pattern called? Write the equation describing intensity distribution.

(d) If an unpolarised light is passed through a calcite crystal, it splits into o-ray and e-ray.

What is the state of polarization (SOP) of o-ray and e-ray ?

What is the condition on displacement vector D for o-ray and e-ray ?

(e) What are the differences between direct band gap and indirect band gap materials, emphasize on

- energy momentum diagram
- example of materials for both types
- applications of both types in various device fabrication

(f) Write the following in the order of increasing resolving power :

Prism, Fabry Perot interferometer, diffraction grating (3×5)

2. (a) Light of $\lambda = 0.5\ \mu m$ is used in a Michelson Interferometer. The separation between the two mirrors is $d = 0.3$ mm, find the angles at which the first five dark rings will occur. Find the corresponding order of these dark rings. (8)

(b) Fresnel coefficient of reflection for a parallel polarized wave is as follows:

$$r = \tan(\theta_1 - \theta_2) / \tan(\theta_1 + \theta_2)$$

where θ_1 , θ_2 are the angles of incidence and reflection respectively.

Starting with this information, derive Brewster law and discuss its application in obtaining an linearly polarised (LP) light. (3+4)

3. (a) In Fabry perot interferometer, the Transmittivity T of the film is given by

$$T = (1 + F \sin^2(\delta/2))^{-1}$$

Where F is the coefficient of Finesse, and δ is the phase difference between two successive waves emanating from the film.

From the given information, obtain the expression for Reflectivity. (2)

Plot (roughly) Transmittivity for very small value of F (e.g., F=2) and very large value of F (e.g., F = 400). (5)

(b) Calculate the value of reflectivity for F=2 and F=400. (5)

(c) What is a missing order in N-slit diffraction pattern ? (3)

4. (a) A linearly polarized (LP) light is incident at an angle 45° to the fast axis of a half wave plate (HWP) made of Calcite. Find out mathematically the state of polarization (SOP) of the emergent beam. (8)

(b) 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 ? (7)

5. (a) Discuss three differences between an achromatic doublet and a separated doublet for removal of chromatic aberration. (3)

(b) Obtain an expression for the numerical aperture of a step index optical fiber. (5)

(c) In the 2P → 1S transition in the hydrogen atom, the life time of the 2P state for spontaneous emission is given by $t_{sp} = 1.6 \times 10^{-9}$ s; the frequency of transition is $\omega \approx 1.55 \times 10^{16}\ s^{-1}$. Find Einstein A and B coefficients. (7)

6. (a) Write differences between holography and photography. (3)

(b) What is a line shape function ? Discuss the interaction of atoms with a broad spectrum radiation, and with a monochromatic radiation. (2+3+3)

(c) Describe the working of a semiconductor injection laser diode. (4)