

U.G. 4th Semester Examination-2025**PHYSICS****[MAJOR]****Course Code : PHY-MJ-T-4****(Wave Optics and Electro-magnetic Theory)****[NEP-2020]**

Full Marks : 40

Time : $2\frac{1}{2}$ Hours*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.*

Symbols have their usual meaning.

GROUP-A1. Answer any **five** of the following questions: $2 \times 5 = 10$

- a) Write two differences between the fringes produced by Lloyd's Mirror and Fresnel's Biprism.
- b) Calculate the least thickness of a retarded plate which would convert a plane polarised light into circularly polarised light. Given $n_o = 1.658$, $n_e = 1.486$ and wavelength of light is $5890 \text{ \AA}$.
- c) Where will a person hear maximum sound, at node or antinode? Explain.

[Turn over]

- d) What is missing order in double slit pattern?
- e) Can electric field, $\vec{E}(\vec{r}, t) = E_0 \hat{x} \sin^3(z - ct)$ be an electromagnetic wave?
- f) Distinguish between Fresnel and Fraunhofer class of diffractions.
- g) What are positive and negative crystals?
- h) Show that refractive index of a dielectric medium, $n = \sqrt{k}$, (k = dielectric constant of the medium).

GROUP-B

2. Answer any **two** of the following questions: $5 \times 2 = 10$

- a) What is the physical significance of Poynting vector? Show that average Poynting vector, $\langle \vec{S} \rangle = \vec{E}_{rms} \times \vec{H}_{rms}$. 2+3
- b) For Fraunhofer pattern of double slit deduce the expression of intensity. Distinguish between the resolving power and dispersive power of grating. 3+2
- c) How can you distinguish between an elliptically polarised light and a mixture of plane polarised and unpolarised light? Determine the Brewster's angle for glass of refractive index 1.5 immersed in water of refractive index 1.33. 3+2

- d) Deduce the relation between group velocity and phase velocity. A thin transparent plate of refractive index 1.5 is introduced in one arm of Michelson interferometer. It causes 10 fringes shift. Find the thickness of the plate. $[\lambda = 600 \text{ nm}]$ 2+3

GROUP-C

3. Answer any **two** of the following questions: $10 \times 2 = 20$

- a) Discuss the construction and working principle of Nicole prism. State Biot's law of optical rotation. The plane of polarisation of plane polarised light is rotated through 6.5° in passing through a length of 2 decimeter of sugar solution of 5% concentration. Calculate the specific rotation of the sugar solution.

5+2+3

- b) What is zone plate? Show that a zone plate has multiple foci. What are the differences between a convex lens and zone plate? What are Fresnel's integrals?

1+5+2+2

- c) Deduce the Fresnel's laws of reflection of electromagnetic wave at the boundary between two dielectric media. An electromagnetic wave is incident normally on a dielectric-dielectric interface for which $\mu_1 = \mu_2 = \mu_0$ and refractive indices n_1 and n_2 respectively. Show that the reflectance R and transmittance T are given by

$$R = \frac{(n_1 - n_2)^2}{(n_1 + n_2)^2}; \quad T = \frac{4n_1 n_2}{(n_1 + n_2)^2}. \quad 6+4$$

- d) Derive an expression for the wavelength of monochromatic light source used in Newton's rings experiment in terms of diameters of rings and radius of curvature of the lens used. Draw a ray diagram of the light path in a Michelson's interferometer. What do you mean by Haidinger Fringes? Give an example. 6+2+2
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