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-A

1. Answer any **five** of the following questions: $2\times5=10$

a) Write two differences between the fringes produced by Lloyd's Mirror and Fresnel's Biprism.

b) Calculate the least thickness of a retarted plate which would convert a plane polarised light into circularly polarised light. Given $n_0 = 1.658$, $n_e = 1.486$ and wavelength of light is 5890 Å.

c) Where will a person hear maximum sound, at node or antinode? Explain.

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: 5×2=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. [$\lambda = 600$ nm] 2+3

GROUP-C

3. Answer any **two** of the following questions: 10×2=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

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