

SH-VI/PHSH/CC-XIII/25

B.Sc. 6th Semester (Honours) Examination, 2025 (CBCS)

Subject : Physics

Course : CC-XIII

(Electromagnetic Theory)

Time: 2 Hours

Full Marks: 40

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

1. Answer any five of the following questions:

2×5=10

- (a) State the Poynting theorem.
- (b) What is the physical significance of the displacement current?
- (c) How is the relative permittivity of a non-magnetic dielectric medium ($\mu = \mu_0$) related to the refractive index of the medium? Calculate refractive index for a medium of relative permittivity $\epsilon_r = 4$.
- (d) State Brewster's law. Determine the Brewster angle for light incident from glass ($n = 1.5$) to water ($n = 1.33$).
- (e) Is energy transmitted in total internal reflection? What is an evanescent wave?
- (f) A Right Circularly Polarized (RCP) light wave and a Left Circularly Polarized (LCP) light wave were each passed through a quarter-wave plate. Would they produce identical output light? Justify.
- (g) What is the skin depth of a conducting medium? Find the skin depth in copper at 60 Hz.
[Given : $\mu = \mu_0, \sigma = 5.8 \times 10^7 \text{ S/m}$].
- (h) What are vector and scalar potentials? How are they related to E field and B field?

2. Answer any two of the following questions:

5×2=10

- (a) What is an optical fibre? With a necessary diagram of a step-index fibre, find the expression of numerical aperture and acceptance angle. 1+2+2
- (b) Define 'optic axis' and the 'principal section' of a crystal. Draw the wave surfaces for the ordinary (o-ray) and extraordinary (e-ray) in positive and negative uniaxial crystals. Give one example for each. 2+2+1
- (c) In a non-magnetic medium ($\mu = \mu_0$), electric field is given:
 $\vec{E}(z, t) = 4 \sin(2\pi \times 10^7 t - 0.8z) \hat{i} \text{ V/m}$.
Find relative permittivity ϵ_r , wave impedance and time average of the Poynting vector. 1+2+2
- (d) What is Babinet's compensator? Why is it called compensator? What are the practical applications of Babinet's Compensator? 2+2+1

3. Answer any two of the following questions:

10×2=20

- (a) An electromagnetic plane wave undergoes reflection and refraction at the interface of two isotropic dielectric media. Using Maxwell's equations and proper boundary conditions, obtain the laws of reflection and refraction.
- (b) A plane electromagnetic wave is incident normally on an air-metal interface. Introducing the idea of a complex refractive index, obtain an approximate expression for reflecting power of the metal. Hence show that a perfect conductor is a perfect reflector of electromagnetic waves.
- (c) What is rotatory polarization? Define specific rotation of optically active substances. Describe in brief Laurent's half shade polarimeter and explain the action of half shade to determine specific rotation.
- (d) With necessary diagrams, explain the structure and working principle of a planar dielectric waveguide. Discuss the role of mode number in planar waveguides. How does core thickness affect it?

7+3

2+2+3+3

6+3+1