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May 2026

B.SC. (PHYSICS) VI SEMESTER

Electromagnetic Theory (BPH–601A)

Time : 3 Hours] [Maximum Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any **four** questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART–A

1. (a) Write Maxwell's equations in integral form. (1.5)

   (b) Represent the electric and magnetic field notation in complex form for an EM wave. (1.5)

   (c) Define skin depth on the basis of electromagnetic theory. What is its value for copper? (1.5)

   (d) Find the value of uniform magnetic field if magnetic vector potential is $B_0\left(x^2y\hat{i}-2xz\hat{j}\right)$, where $\hat{i}$ and $\hat{j}$ are unit vectors. (1.5)

(e) Determine the thickness of a quarter wave plate of a calcite which can produce circular polarized light. For calcite $\lambda = 5893 \times 10^{-8}$ cm.

(Given $\mu_0 = 1.658$ and $\mu_e = 1.486$). (1.5)

(f) What is displacement current? (1.5)

(g) Explain uniaxial and biaxial crystals. (1.5)

(h) Refractive index of water is 1.33. Calculate the angle of polarization for light reflected from the surface of a pond. (1.5)

(i) What is an optical fibre? What is the phenomenon on which it works? (1.5)

(j) What do you mean by total internal reflection? Write its necessary conditions. (1.5)

PART–B

2. (a) Describe the concept of Poyntings theorem. Drive an expression to calculate the Poynting vector. (8)

(b) Define Coulomb and Lorentz Gauge. (4)

(c) Explain Scalar and Vector potentials. (3)

3. Discuss the following in brief: (15)

(i) Transverse nature of plane EM waves.

(ii) Refractive index.

(iii) Dielectric constant.

(iv) Wave impedance.

(v) Brewster's Law.

4. Describe the construction of a Nicol Prism with suitable diagram. Explain its working principle as a polarizer and as an analyzer. (15)

5. (a) Explain the phenomena of Electromagnetic wave propagating through conducting medium. (8)

(b) Define the term TE, TM and TEM in wave guide. Calculate the lowest cutoff frequency of a rectangular (10 cm height and 5 cm width) waveguide. (7)

6. (a) Derive an expression of Fresnel's equations for oblique incidence when electric field vector E is polarized parallel to the plane of incidence. (10)

(b) The wavelength of a wave is 200 Å with wave vector K. If we double the wave vector then what will be the wavelength of the wave in Å? (5)

7. Write short notes on the following: (15)

(i) Electromagnetic energy density.

(ii) Double refraction.

(iii) Phase and group velocity of guided waves.

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