7. (a) Calculate the reflection and transmission coefficients of an electromagnetic wave is moving from region one, which is free space, into region two, which has a relative dielectric constant of 4. (5)

(b) Derive an expression for wave equation for electric field E and magnetic field B in vacuum. (5)

(c) Discuss about the importance of Maxwell's Stress Tensor to calculate force per unit area acting on the surface. (5).

Roll No. ..... Total Pages : 4

321602

May-2026

(Physics) B.Sc.-VI SEMESTER

Electromagnetic Theory (BPH24-601T)

Time : 3 Hours] [Max. 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.*
4. *Use of scientific calculator is allowed.*

PART–A

1. (a) Write Integral form of four Maxwell's equations in free space? (1.5)

(b) What do you mean by continuity equation? (1.5)

(c) Show that Electric vectors of incident, reflected, transmitted waves are in same direction. (1.5)

(d) Calculate the skin depth of a conductor at 1 GHz, given that $\sigma = 3.8\times10^{7}$ mho/m, $\mu = 2.57\times10^{-7}$ H/m. (1.5)

(e) What is the magnetic field if the electric field of a plane electromagnetic wave is given by $E = E_0 \cos(kz) \cos(\omega t)\, \hat{x}$. (1.5)

(f) Vector potential $A = (x^2y)_i + (y^2z)_j + (z^2x)_k$ satisfies the coulomb gauge condition or not, where i, j and k are unit vectors. (1.5)

(g) What do you understand the term total internal reflection? (1.5)

(h) Define the law of reflection and transmission in oblique incidence of electromagnetic waves. (1.5)

(i) Discuss about of Velocity of an Electromagnetic Wave in vacuum with expression. (1.5)

(j) Calculate the displacement current using Maxwell's correction for conductors if the value of electric field is $E = E_0 \sin(\omega t)$. (1.5)

PART–B

2. (a) Discuss about the concept of conservation of momentum in electromagnetic field. (5)

(b) Derive the expression for the Poynting vector and momentum in the electromagnetic field. Calculate energy per unit time transported by the wire of potential difference V between the ends, length L, radius 'a' and current 'I' passing through it. (10)

3. (a) Derive an expression of Fresnel's equations and calculate coefficient of reflection and transmission of EM waves at the plane boundary separating by two linear media when incident wave is polarised with electric vector E normal to the plane of incidence. (10)

(b) Find the boundary conditions at a plane interface between two media when there is no free charge or free current at the interface? (5)

4. (a) Find the expression for the skin depth and absorption coefficient in case of Electromagnetic wave propagating through conducting medium and show that the amplitude of electromagnetic waves in conducting medium dies gradually. (10)

(b) Calculate the wavelength of the electromagnetic wave if the magnetic field of an Electromagnetic Wave is given by $B_Y = 3 \times 10^{-7} \sin(10^3 x + 6.29 \times 10^{12} t)$.

5. (a) Derive the expression for the energy and momentum of monochromatic electromagnetic plane wave. (5)

(b) Find the velocity and intensity of the electromagnetic (EM) wave given by the electric field equation $E = 250 \sin(1.5 \times 10^7 z - 4.5 \times 10^{15} t)$. (Given $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m). (5)

(c) What are Gauge transformations? Discuss about the Lorentz and Coulomb gauge transformation. (5)

6. (a) Find the expression for wave impedance of electromagnetic wave propagating in isotropic dielectric medium. (8)

(b) Starting from first principles, derive expressions for the Brewster angles pertaining to reflection of a plane wave at oblique incidence, in the cases of parallel polarization. (7)