April 2025
B.A./B.Sc.
Sixth Semester
CORE – 13
PHYSICS
Course Code: PHC 6.11
(Electromagnetic Theory)

Total Mark: 70   *Pass Mark: 28*
Time: 3 hours

Answer <u>five</u> questions, taking <u>one</u> from each unit.

UNIT–I

1. (a) Establish the boundary condition for the tangential component
       of **E**.   6
    (b) Evaluate the Coulomb and Lorentz gauges and show that the
       d'Alembertian plays the same role in four dimensions as
       Laplacian plays in classical mechanics.   8

2. (a) Justify the potential formulation in electrodynamics and show
       that the four Maxwell's equations reduce to two inhomogeneous
       wave equations in terms of the vector and scalar potentials.   8
    (b) The earth receives 2 cal min^{-1} cm^{-2} solar energy. Calculate the
       amplitude of electric and magnetic field of radiation.   3
    (c) Calculate the average solar energy incident on the earth, if the
       average distance between the sun and the earth is
       0.0015×10^{11} km.   3

UNIT–II

3. (a) Show that the field vectors **E**, **H**, & **K** are mutually
       perpendicular to each other during the propagation of an
       electromagnetic wave in an isotropic medium.   7
    (b) Calculate in detail the skin depth of an electromagnetic wave
       propagating in free space.   7

4. (a) The electric field of an electromagnetic wave propagating through free space is represented as

$\mathbf{E}(\mathbf{r},t) = E_0 \cos(25\sqrt{3}\,\pi x - 25y - \omega t)\hat{z}$

   (i) Calculate the propagation vector along z-axis and compute the value of ω.   3

   (ii) Calculate the skin depth for electromagnetic wave of frequency 100 MHz in copper of conductivity 6.25×10^7 mho/m ($\mu_o = 4\pi\times10^{-7}$ H/m).   3

   (c) Compute the intrinsic impedance of copper at a frequency of 3×10^9 hertz and conductivity of 5.8×10^7 mho/m. ($\mu_r = 1, \varepsilon_r = 1$).   3

   (d) Establish the propagation of electromagnetic wave in a conducting media   5

UNIT–III

5. (a) Calculate the reflection and transmission coefficient at normal incidence for an electromagnetic wave propagating between two non-conducting media.   7

   (b) Derive the Fresnel's equation for the reflection and refraction of electromagnetic waves at a plane boundary separating two media, when the incident wave is polarized parallel to the plane of incidence.   7

6. (a) Evaluate the phenomenon of total internal reflection during the propagation of electromagnetic waves.   8

   (b) Calculate the reflection coefficient for perpendicular and parallel component of ordinary light reflected from glass of refractive index 1.5 at an angle of incidence 45°.   6

UNIT–IV

7. (a) Establish the theory and working of a Babinet compensator. Write one use of the instrument.   5+1=6

   (b) Establish the theory of plane, elliptical, and circularly polarized light.   8

8. (a) A small-angled wedge of quartz is placed between two crossed Nicols. A parallel beam of wavelength 6000 Å is incident on the

plate cut with its optic axis parallel to the edge of the wedge. Interference fringes observed on the faces of quartz is 1.52 cm apart. Calculate the wedge angle of quartz plate. (Given $\mu_0 = 1.544$ and $\mu_E = 1.553$). 4

(b) What is the wavelength of light required to convert a plane polarized light into circularly polarized light if the minimum thickness is 0.856 μm with a difference of refractive index between the ordinary and extra ordinary light is 0.172? 4

(c) Write short notes on birefringence. 3

(d) Evaluate the thickness of a half wave plate. 3

UNIT–V

9. (a) Explain the phenomenon of optical rotation and how optically active substances are further subdivided. 5

(b) State the law of the rotation of plane of polarization. 3

(c) Discuss the experimental verification of Fresnel's theory of optical rotation. 6

10. (a) Calculate the thickness of a quartz crystal that will rotate the plane of polarization of sodium yellow light by 90 degrees. 2

(b) Compute the amount of sugar required for a solution contained in a 10 cm long tube containing 36 cc of sugar solution with a value of 66 degrees for the specific rotation of sugar that produces an optical rotation of 11 degrees when place in a saccharimeter. 4

(c) What are the types of optical fibre based on the modes of light propagation? Explain any one of them. 1+4=5

(d) Write a short note on the classification of optical fibre based on its structure. 3

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