2023
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 five *questions, taking* one *from each unit.*

UNIT–I

1. (a) Establish the boundary condition for the tangential component of H. 6

   (b) Derive the four-dimensional Poisson's equation by using the concept of Coulomb's 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) Discuss 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) A parallel plate capacitor with circular plates of radius *a* is charged. Compute the electromagnetic energy flux through the lateral surface of the capacitor after neglecting the fringing effect. 6

UNIT–II

3. (a) Show that the field vectors $\vec{E}, \vec{H}$ and $\vec{K}$ are mutually perpendicular to each other during the propagation of an electromagnetic wave in an isotropic medium. 7

   (b) Derive an expression for the skin depth of an electromagnetic wave propagating in an isotropic medium. 7

4. (a) Derive an expression for the reflection coefficient at a conducting surface. 7

(b) Explain the propagation of electromagnetic waves in ionosphere. 4

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

$$\vec{E}(r,t) = E_0 \cos(100\sqrt{3}\pi x - 100y - \omega t)\hat{z}$$

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

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) Show that the transmitted part of an electromagnetic wave is propagated only parallel to the surface and is attenuated exponentially beyond the surface. Explain evanescent wave. 6+2 =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) Discuss the theory and working of a Babinet compensator. Write one use of the instrument. 5+1=6

(b) Write short notes on the following: 4×2=8

(i) Polarization of electromagnetic waves

(ii) Birefringence

8. (a) How are plane polarized, elliptically polarized and circularly polarized light produced experimentally? 6

(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) Explain the working of a half wave plate. Calculate its thickness. 4

UNIT–V

9. (a) Derive the condition of continuity at interface during the propagation of an electromagnetic wave. 7

(b) Explain step and graded indices. 4

(c) A step index fibre is with a core of refractive index 1.56 and cladding of refractive index 1.50. Calculate the intermodal dispersion per kilometre of length of the fibre and the total dispersion in a 10 km length of the fibre. 3

10. (a) Discuss the classification of optical fibre based on its structure. 5

(b) Discuss the experimental verification of Fresnel's theory of optical rotation. 5

(c) Explain the construction and working of a Laurent's half shade polarimeter. 4