TDC (CBCS) Even Semester Exam., 2024

PHYSICS

(6th Semester)

Course No. : PHSHCC–601T

(Electromagnetic Theory)

Full Marks : 50
Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

UNIT—I

1. Answer any *two* of the following questions : 2×2=4

(a) What is displacement current density? Is it linked with the motion of free charges?

(b) Mention the advantage and disadvantage of Coulomb gauge.

(c) State Poynting theorem.

2. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] : 6

(a) Write down Maxwell's equations of electromagnetism. 2

(b) Explain the physical significance of each equation. 4

(c) What do you mean by scalar and vector potentials? 2

(d) Explain gauge transformation. Discuss Lorentz gauge. 2+2=4

UNIT—II

3. Answer any *two* of the following questions : 2×2=4

(a) Show that wave impedance of free space is $120\,\pi\,\Omega$.

(b) Mention two characteristics of plasma.

(c) What is Van Allen radiation belt?

4. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] : 6

(a) Starting from Maxwell's equations, show that in a dielectric medium—

(i) $\nabla^2\vec{E} = \mu\varepsilon\dfrac{\partial^2\vec{E}}{\partial t^2}$

(ii) $\nabla^2\vec{H} = \mu\varepsilon\dfrac{\partial^2\vec{H}}{\partial t^2}$ 2½+2½=5

(b) What is the relation between refractive index and dielectric constant? 1

(c) What do you mean by skin depth? Calculate the frequency at which the skin depth in sea water is 1 m. (Given, $\sigma = 4{\cdot}3$ mho m^{-1} and $\mu = 4\pi \times 10^{-7}$ H m^{-1}) 2+2=4

(d) Explain relaxation time. 2

UNIT—III

5. Answer any *two* of the following questions : 2×2=4

(a) State the laws of reflection of electromagnetic waves.

(b) Explain total internal reflection.

(c) What is an evanescent wave?

6. Answer *either (a) or (b)* : 6

(a) Derive Fresnel's formulae for reflection and refraction of electromagnetic waves at a plane boundary separating two dielectric media when the incident wave is polarized with $\vec{E}$ perpendicular to the plane of incidence. 6

(b) Define reflection and transmission coefficients. What is the sum of reflection and transmission coefficients? State Brewster's law of polarization. Mention one practical application of Brewster's law. 2+1+2+1=6

UNIT—IV

7. Answer any *two* of the following questions : 2×2=4

(a) State the differences between uniaxial and biaxial crystals.

(b) Explain double refraction.

(c) Mention two uses of Babinet compensator.

8. Answer *either (a) or (b)* : 6

(a) Describe the construction of Nicol prism. Discuss the action of Nicol prism as a polariser. 3+3=6

(b) What is a quarter-wave plate? How can it be used to produce circularly polarized light? Calculate the thickness of quarter wave plate for light of wavelength 5893 Å. (Given, $\mu_o = 1{\cdot}544$, $\mu_e = 1{\cdot}553$) 2+2+2=6

UNIT—V

9. Answer any *two* of the following questions : 2×2=4

(a) What do you mean by wave guide?

(b) Mention two advantages of wave guide.

(c) Distinguish between single and multiple mode optical fibres.

10. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] : 6

(a) Distinguish between group velocity and phase velocity of guided waves. 3

(b) Find the relationship between phase velocity and group velocity. 3

(c) Obtain expression for numerical aperture of an optical fibre. 4

(d) Numerical aperture of an optical fibre is 0·5 and core refractive index is 1·48. Find the cladding refractive index. 2

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