2024

(May)

PHYSICS

Core Course

(Electro-Magnetic Theory)

Course Code : **PHY-CC-T4-601**

Credit : 4

Total Marks : 56   Time : $2\frac{1}{2}$ Hours

The figures in the margin indicate full marks
for the questions

1. Show that electric and magnetic fields are invariant under Gauge transformation.   3

2. (*a*) Derive Maxwell's equations in terms of scalar and vector potentials.   5

Or

   (*b*) Calculate the electric field inside and outside of a solid cylinder of infinite length with uniform charge density and radius *r*.   5

3. Show that continuity equation is contained within Maxwell's equations.   2

4. Show that the vector potential for an uniform magnetic field $\vec{B}$ is— 2

$$\vec{A} = \frac{-1}{2}\left(\vec{r} \times \vec{B}\right)$$

where $\vec{r}$ the position vector of any arbitrary point.

5. Considering the case of electromagnetic waves in vacuum, prove that they are transverse in nature. Moreover, the electric and the magnetic fields are mutually perpendicular. 5

6. Show that electromagnetic waves inside conductor takes the form— 4+2=6

$$\nabla^2 \vec{E} = \mu\varepsilon \frac{\partial^2 \vec{E}}{\partial t^2} + \mu\sigma \frac{\partial \vec{E}}{\partial t}$$

and $\nabla^2 \vec{B} = \mu\varepsilon \dfrac{\partial \vec{B}}{\partial t} + \mu\sigma \dfrac{\partial \vec{B}}{\partial t}$

Further, prove that this makes the wave vector complex. What is its consequence ?

7. (a) When electro-magnetic waves travels from one medium to another medium, what are the boundary conditions for the electro-magnetic field ? Prove the boundary conditions for the magnetic field. 4

(b) Find the reflection and transmission coefficient for electro-magnetic waves going from one to another medium at normal incidence. Prove that sum of the two is unity. 5

8. (a) What is polarisation ? Discuss about plane and elliptically polarised light. 4

(b) Write short notes on the following : $3 \times 2 = 6$

(i) Double refraction

(ii) Quarter wave plate

(iii) Half wave plate

9. What are Biot's laws for rotatory polarisation ? What is specific rotation ? $3+1=4$

10. Why the refractive indics of core and cladding are different in an optical fibre ? Which one has greater refractive index ? 2

11. What are acceptance angle, critical angle and numerical aperture ? A step index fibre has core and cladding refractive index of 1.50 and 1.46 respectively. What are values of numerical aperture and acceptance angle of the fibre ? $1+1+1+2=5$

12. Differentiate between step and graded index optical fibre ? 3

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