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Code No. : 8379

Sub. Code : HPHM 22

M.Sc. (CBCS) DEGREE EXAMINATION, APRIL 2014.

Second Semester

Physics

ELECTROMAGNETIC THEORY

(For those who joined in July 2012 onwards)

Time : Three hours

Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. Which of the following method cannot be used to calculate electric field intensity
 - (a) using Gauss law
 - (b) using $E = \frac{\int \rho dz}{4\pi \epsilon r^2}$
 - (c) using Laplace equation
 - (d) using Biot-Savart law

2. The dielectric constant for water is ———.

- (a) 1
- (b) 80.1
- (c) 99
- (d) 5.7

3. The vector potential of a single magnetic dipole $\vec{m}$ is

- (a) $\vec{A}(\vec{r}) = \frac{4\pi \vec{m} \times \vec{r}}{\mu_0 r^2}$
- (b) $\vec{A}(\vec{r}) = \frac{\mu_0 \hat{m} \times \hat{r}}{4\pi r^2}$
- (c) $\vec{A}(\vec{r}) = \frac{\mu_0 \hat{m} \cdot \hat{r}}{4\pi r^2}$
- (d) $\vec{A}(\vec{r}) = \frac{4\pi \hat{m} \cdot \hat{r}}{\mu_0 r^2}$

4. A magnetic field exerts a force on charged particle

- (a) always
- (b) if the particles at rest
- (c) if the particle is moving along the field lines
- (d) if the particle is moving across the field lines

5. The energy per unit time per unit area transported by the fields is called the

- (a) Laplace vector
- (b) Lorentz vector
- (c) Faraday vector
- (d) Poynting vector



6. The Newmann formula is

(a) $\mu_{21} = \frac{\mu_0}{4\pi} \oint \oint \frac{dl_1 \cdot dl_2}{r}$

(b) $\mu_{21} = \frac{\mu_0}{4\pi} \oint \oint \frac{dl_1 \times dl_2}{r}$

(c) $\mu_{21} = \frac{\mu_0}{4\pi} \oint \oint \frac{dl_1 + dl_2}{r}$

(d) $\mu_{21} = \frac{\mu_0}{4\pi} \oint \oint \frac{dl_1 \pm dl_2}{r}$

7. When an electro magnetic wave is incident at the interface between different electric media, the sum of coefficient of reflection and transmission must

- (a) zero (b) <1
(c) >1 (d) equal to 1

8. Fresnel's equation relates the amplitude of the _____

- (a) reflected and transmitted waves with that of incident wave
(b) reflected and transmitted waves
(c) the reflected wave and surface normal
(d) incident wave and surface normal

9. The blueness of the sky is due to the dependence of power on

- (a) w^2 (b) $w^3 \rho^2$
(c) ρ^3 (d) w^4

10. The zone for which the distance from the dipole is _____ the distance between the dipole (d) is called radiation zone

- (a) less than
(b) equal to
(c) greater than
(d) very very greater that

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b), each answer should not exceed 250 words.

11. (a) Find the field outside a uniformly charged solid sphere of radius R and total charge q .

Or

(b) Show that $W = \frac{-1}{4\pi\epsilon_0} \frac{q^2}{4d}$.



12. (a) Find the magnetic field of a uniformly magnetized sphere.

Or

- (b) Show the energy of a magnetic dipole in a magnetic field is $U = -\vec{m} \cdot \vec{B}$.
13. (a) Imagine an iron sphere of radius R that carries a charge Q and a uniform magnetization $\mu = \mu_z$. The sphere is initially at rest. Compute the angular momentum stored in the electromagnetic fields.

Or

- (b) Explain scalar and vector potential.
14. (a) Obtain the electrodynamic boundary conditions for $\vec{E}$ and $\vec{B}$ in linear media.

Or

- (b) Suppose $Ae^{iax} + Be^{ibx} = Ce^{icx}$, for some nonzero constants A, B, C, a, b, c for all x . Prove that $a = b = c$ and $A + B = C$.
15. (a) Derive an expression for Lienard's generalization of Larmor formula.

Or

- (b) Show that $\vec{E}(r, t) = \frac{1}{4\pi\epsilon_0} \int \frac{\rho(r', t)}{r^2} \hat{r} dz'$ i.e. Coulomb's law hold's with charge density evaluated at non-retarded time.

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PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b), each answer should not exceed 600 words.

16. (a) Discuss and explain the relation between susceptibility, permittivity and dielectric constant of linear dielectrics.

Or

- (b) Use Gauss's law to find the electric field inside and outside a spherical shell of radius R_1 which carries a uniform surface charge density σ .
17. (a) Obtain the expression for magnetic force on a volume current.

Or

- (b) Explain the mechanism responsible for diamagnetism.
18. (a) A long cable carries current in one direction uniformly distributed over its cross-section. The current returns along the surface, i.e. there is a very thin insulating sheath separating the currents. Find the self-inductance per unit length.

Or

- (b) Use Maxwell stress tensor how will you determine the net force on the charges.

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19. (a) Obtain Fresnel's equations and explain with neat diagram.

Or

- (b) Obtain the expression for electro magnetic waves in conductors wave guide.
20. (a) Suppose $\vec{v}$ and $\vec{a}$ are instantaneously collinear at time t_r . Find the angular distribution of the radiation and the total power emitted.

Or

- (b) Obtain Lienard's generalization of the Larmor formula.
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