Extra

Time: 2 ½ Hrs Marks 75

N.B.:

1. **All** questions are **compulsory**.
2. **Figures** to the **right** indicate **full** marks.
3. Draw **neat** diagrams wherever **necessary**.
4. Symbols have usual meaning unless otherwise stated.
5. Use of **non-programmable** calculator is allowed.

1. (a) Attempt any **one: -**

(i) Explain the basic electrostatic properties of ideal conductors. **10**

(ii) Suppose a point charge **q** is held a distance **d** above an infinite grounded conducting plane. Show that the total charge induced on the plane is **-q** based on the classic image problem. **10**

(b) Attempt any **one: -**

(i) Show that $\vec{\nabla}.\vec{E} = \frac{\rho}{\varepsilon_0}$, symbols with usual meaning. **5**

(ii) Determine electric field due to potential $V = 2x^2 + 3y^3 + 4z^4$. **5**

2. (a) Attempt any **one: -**

(i) Obtain an expression for the differential form of Ampere's law using curl of magnetic field. **10**

(ii) Obtain an expression for the integral form of Gauss's law in terms of free charge density (ρ_f), hence show that the electrostatic field within dielectric $\vec{E}$ is the polarising field $\overrightarrow{E_0}$ less than field due to polarisation $\overrightarrow{E_p}$. **10**

(b) Attempt any **one: -**

(i) Explain the effect of non-uniform electric field on polar molecule. **5**

(ii) Consider a coaxial solenoids, each carrying a current **I** in opposite direction. The inner solenoid of radius **'a'** has n_1 turns per unit length and the outer solenoid of radius **'b'** has n_2 turns per unit length. Find the magnetic field (i) inside the inner solenoid (ii) between two solenoids (iii) outside both solenoids. **5**

3. (a) Attempt any **one: -**

(i) Obtain the boundary conditions for the fields: Electric field $\vec{E}$, Electric Magnetic field $\vec{B}$ at the interface between two linear media. **10**

(ii) Derive maxwell's equation in material media. **10**

(b) Attempt any **one: -**

(i) How Maxwell (Fixed) modified the Amper's Law? **5**

(ii) In a medium of permittivity $5\,\epsilon_0$, the maximum current is equal to maximum conduction current at frequency of 10^6 Hz. What is the conductivity of the medium? ($\epsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$) **5**

4. (a) Attempt any **one: -**

(i) Consider a wave travelling along z – axis in a medium with refractive index n. If it is incident on the medium with refractive index n_2 normally, calculate the reflection coefficient. **10**

(ii) State Poynting's work energy theorem. Show that $\frac{dw}{dt} = -\frac{\partial}{\partial t}\int_v (u_e + u_m)\, dv - \oint_s \vec{S}.\hat{n}da$. Symbols have their usual meaning **10**

(b) Attempt any **one: -**

(i) Derive the wave equation for the electric field in vacuum. **5**

(ii) For a certain medium $\varepsilon = 17.7\times10^{-12}\ C^2/Nm^2$ and $\mu = 4\pi\times 10^{-7}\ N/A^2$.Find the velocity of plane EM wave in the medium. Also find the refractive index of the medium? ($c=3\times 10^8$ m/s, $\varepsilon_0 = 12.85\times10^{-12}\ C^2/Nm^2$) **5**

5. Attempt any **Five: -**

(i) Find the energy of a uniformly charged spherical shell of total charge 3 μC. **3**

(ii) Find the work done to a move a charge of 2 Coulombs under the influence of potential difference 3 Volts. **3**

(iii) A vector field is given by $\vec{B} = 3yz\,\hat{i} + 2zx\,\hat{j} + 4xy\,\hat{k}$ Find the current density in the field at point (2, 4, -1). $\mu_0 = 4\pi \times 10^{-7}\ SI\ units.$ **3**

(iv) Find the magnetic field of an infinite uniform surface current $K = K\hat{x}$, flowing over the XY plane 3

(v) The magnetization is given by $\bar{M} = a\left[3xy\,\hat{i} + 5yz\,\hat{i} + 5xz\,\hat{k}\right]$ where 'a' is a constant find $\vec{J}_b$ and $\vec{\nabla}.\vec{J}_b$ 3

(vi) Show that $\vec{\nabla}.\vec{J}_b = 0$. 3

(vii) An electromagnetic wave is incident normally on the surface of glass from air. Find the coefficient of transmission. Given **(n_2=1.5)** 3

(viii) Electromagnetic wave in empty space has amplitude of electric field 400V/m. Find the value of amplitude of magnetic field **(c=3x10^8 m/s)** 3

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