(3 *hrs*) **Total Marks : 100**

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.

Constants: 1] $\varepsilon_0 = 8.85 \times 10^{-12} C^2/Nm^2$

2] $\mu_0 = 4\pi \times 10^{-7} N/A^2$

3] Electronic charge = $1.6 \times 10^{-19} C$

1. Attempt any **Two:---**

(a) A point charge 'q' is held at a distance'd' above an infinite grounded conducting plane. Determine the potential in free space above the plane and determine the total induced charge on the plane. **10**

(b) Derive Gauss's law in free space in integral and differential form. Find the electric field inside a uniformly charged sphere having charge density ρ. **10**

(c) State and prove First and Second Uniqueness theorems. **10**

2 Attempt any **Two:---**

(a) Derive an expression for potential due to a polarized object in terms of bound charges. Show that $\sigma_b = \bar{P} \cdot \hat{n}$ and $\rho_b = \bar{\nabla} \cdot \bar{P}$. **10**

(b) Obtain an expression for the torque experienced by an electric dipole in uniform electrostatic field. **10**

Show that the energy of an ideal dipole p in an electric field E is given by

$$U = -\bar{p} \cdot \bar{E}$$

(c) Derive the expressions for divergence and curl of magnetic field $\bar{B}$ of a volume current $\bar{J}(\bar{r}')$. **10**

3. Attempt any **Two:---**

(a) Derive an expression for energy stored in magnetic fields. **10**

(b) Obtain the boundary conditions for the fields: Electric field $\bar{E}$, Electric Displacement $\bar{D}$, Magnetic field $\bar{B}$ and auxiliary field $\bar{H}$. **10**

(c) State Maxwell's equations in free space. Derive the Maxwell's equations in the matter. **10**

4. Attempt any **Two:---**

(a) A plane wave is incident normally on the interface of two non conducting media. Write the incident, transmitted and reflected field vectors. Apply boundary conditions and derive the expressions for reflection and transmission coefficients. **10**

(b) In case of plane monochromatic wave show that the contribution towards the energy density from magnetic and electric fields are equal. Obtain the expression for average values for energy density, Poynting vector, and momentum density in case of plane monochromatic wave. **10**

(c) State and prove Poynting's theorem. Get the differential version of Poynting's theorem and compare it with continuity equation. **10**

5. Attempt any **Four:**---

(i) If the potential is a function of only position vector r, V(r), then solve the Laplace's equation$\nabla^2 V = 0$. **05**

(ii) Calculate the electric field for an electrostatic system having potential **05**

$$V(r) = k(r - \frac{a^3}{r^2})$$

Where k and a are constants.

(iii) 3.0 Ampere current flows through a solenoid having 2500 turns per meter. Calculate the magnetic field inside and outside the solenoid. (Given: $\mu_0 = 4\pi \times 10^{-7} N/A^2$) **05**

(iv) Determine if any of the following vectors can be magnetostatic field: **05**
(i) $\bar{B} = k[6yz\hat{x} + 3x^2z\hat{y} + 3x^2y\hat{z}]$
(ii) $\bar{B} = k[xy\hat{x} + 2yz\hat{y} + 3xz\hat{z}]$

(v) The magnetic susceptibility of a linear sample of Tungsten is 7.8×10^{-5}. If auxiliary field (H) of 75,000 Ampere.turns/m is applied along the z-axis, find the magnetization M and the magnetic field B in the medium. **05**

(vi) A parallel plate capacitor is immersed in a sea water with permittivity $\varepsilon = 81\varepsilon_0$, permeability $\mu = \mu_0$ and resistivity $\rho = 0.23\Omega.m$. The capacitor is driven by the voltage $V_0\cos(2\pi\nu t)$ and frequency 4×10^8Hz. What is the ratio of conduction current to displacement current? **05**

(vii) Obtain the Wave equation from Maxwell's equations. **05**

(viii) A 3.14 Watt LASER illuminates a spot of radius 0.1 cm .Find the value of Poynting vector at the spot. **05**
