($2\frac{1}{2}$ Hours) **Total Marks : 75**

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

1. (a) Attempt any **one:**---
   (i) Find the potential inside and outside a uniformly charged solid sphere whose radius is R and total charge is q. Use infinity as your reference point. Compute the gradient of V in each region and check it yields the correct field. **10**
   (ii) A point charge q is held at a distance d above and infinite grounded conducting plane, using method of image obtain the expression for
   a) Potential V above the conducting plane.
   b) Force on charge q. **10**
   (b) Attempt any **one:**---
   (i) Show that for electrostatic field curl **E** =0 **5**
   (ii) Determine the electrostatic potential due to an infinite wire carrying a line charge with linear charge density λ, at a distance r from the wire. **5**

2. (a) Attempt any **one:**---
   (i) Starting from Biot-Savart's law obtain expression for $\boldsymbol{\nabla}.\boldsymbol{B}$ and $\boldsymbol{\nabla}\ \mathbf{X}\ \boldsymbol{B}$ **10**
   (ii) Explain the polarization and hence show that the potential of the polarized object is same as that produced by volume charge density $\rho_b = -\boldsymbol{\nabla}.\boldsymbol{P}$ plus a surface charge density $\sigma_b = \boldsymbol{P}.\hat{n}$ **10**
   (b) Attempt any **one:**---
   (i) Show that there is no net charge induced in dielectric due to polarization of the dielectric. **5**
   (ii) For a dipole **P** in a uniform electric field **E** show that net torque acting on the dipole is **N = P X E** **5**

3. (a) Attempt any **one:**---
   (i) What is magnetization? Give physical interpretation of surface and volume bound currents. Why these currents are called as bound currents? **10**
   (ii) Explain the need to modify Ampere's law. Obtain Maxwell's modification to Ampere's law and show that modified form of Amperes law explain the problem of charging of capacitor. **10**
   (b) Attempt any **one:**---
   (i) For linear magnetic materials obtain the relation between magnetic susceptibility χ_m, permeability of material μ and permeability of free space μ_0. **5**
   (ii) Obtain Ampere's law in material in differential and integral form. **5**

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

(i) Obtain Poynting work energy theorem in electrodynamics. What is pointing vector **S**? Obtain continuity equation for **S**. **10**

(ii) A plane monochromatic electromagnetic wave is incident normally on the boundary separating the two dielectric media. Calculate the amplitude of reflected and transmitted waves in terms of amplitude of incident wave. Discuss the phase relationship of reflected and transmitted wave with the phase of incident wave. **10**

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

(i) Show that Newton's third law appears to be violated in electrodynamics. Explain how it is rescued. **5**

(ii) Obtain the average value of energy density and intensity of plane monochromatic electromagnetic wave. **5**

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

(i) Determine the electric field due to potential, $V = x^2 + 2y^2 + 4z^2$ **4**

(ii) Charge +2q and -3q are placed at a points A(0, 0, d) and B(0, 0, 2d) respectively along the z- axis of an infinite earthed conducting plane placed along x-y plane. Find the force on the positive charge. **4**

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

(i) A long narrow solenoid consist of 1000 turns per meter of its length, carries 1.5 A current. Find the magnetic field inside the solenoid. **4**

(ii) Calculate the energy density in uniform electric field of intensity 8 V/m in a linear homogenous medium of dielectric constant 2.28. (Given $\in_0 = 8.85\ x\ 10^{-12}\ C^2/Nm^2$) **4**

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

(i) The non-uniform magnetization of certain material is given by, **4**

$\mathbf{M} = xy\hat{x} + 2yz\hat{y} + 3zx\hat{z}$. Calculate the volume bound current density $\mathbf{J_b}$ at the location (1, 1, 1). All quantities are in SI units.

(ii) The magnetic susceptibility of linear medium is 2.8×10^{-4}. If an auxiliary field $\mathbf{H} = 10^5$ A/m is applied to it along the z direction. Find the magnetization **M** and the magnetic field **B**. Assume $\mu = \mu_0 = 4\pi \times 10^{-7}$ N/A^2. **4**

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

(i) The average value of intensity of sunlight reaching the earth's surface is 1300 W/m^2. Assuming sunlight reaching the earth's surface to be plane and monochromatic, calculate the amplitude of electric field vector associated with it. Given: $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/Nm^2; $C = 3 \times 10^8$ m/s. **3**

(ii) A plane monochromatic electromagnetic wave is normally incident from air ($n_1 = 1$) on glass ($n_2 = 1.5$). Calculate the coefficient of reflection R and coefficient of transmission T. **3**
