(3 Hours) [Total Marks : 100]

N.B. : (1) Question No. 1 is **compulsory**.
(2) Attempt any **four** questions from the remaining questions.
(3) **Figures** ot the **right** indicate **full** marks.
(4) Assume **suitable** data whenever **required**.
(5) Use vector notation wherever **necessary**.

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1. Attempt any **four** of the following :– 20
   (a) Explain the relation $\bar{E} = -\bar{\nabla} V$.
   (b) State and explain Biot – Savarts Law.
   (c) What is uniform plane wave ? Explain its physical significance.
   (d) Obtain the point form of the continuity equation.
   (e) Prove that the tangential component of E is continuous across a dielectric interface.

2. (a) Write and explain Maxwell's equation for static electric and steady magnetic fields. Modify them for time varying fields discussing the inconsistancy of Ampere's law. 12
   (b) Four point charges of 3 n C each are placed at four corners of a square 2 m in side. Find the force acting on each charge. 8

3. (a) Derive an expression for the potential at a distance r from an electric dipole. 8
   (b) The flux density $\bar{D} = \frac{r}{3}\bar{a}_r \left(nc/m^2\right)$ is in the free space :– 12
      (i) Find $\bar{E}$ at r = 0·2 m.
      (ii) Find the total electric flux leaving the sphere of radius = 0·2 m.
      (iii) Find the total charge within the sphere of radius = 0·3 m.

4. (a) State and explain Gauss' law and use it to find the electric field $\bar{E}$ in all regious of a sphere of radius a centered at the origin. The medium is free space. 8
   (b) Find the flux density at a point A(6, 4, –5) caused by :– 12
      (i) a point charge of 20 μC at the origin.
      (ii) a uniform line charge of $\rho_L = 20\ \mu C/m$ on the z axis.
      (iii) a uniform surface charge density $\rho_S = 60\ \mu C/m^2$ at a place x = 8.

5. (a) Derive an expression for the Poynting theorem and state the significance of each term. 8
   (b) Given that $\bar{D} = \frac{10x^3}{3}\bar{a}_x\ c/m^2$, evaluate both sides of the divergence theorem for the volume of a cube, 2 m on the edge, centered at the origin with edges parallel to the axes. 12

6. (a) Derive an expression for Laplace's and Poisson's equation. Hence state and prove Uniqueness theorem. 12
   (b) Two plates of a parallel plate capacitor are separated by a distance d and maintained at potentials O and V_1 respectively. Assuming negligible fringing effect determine the : 8
      (i) Potential at any point between the plates.
      (ii) Surface charge densities on the plates.

7. (a) Explain the magnatic scalar and vector potentials and derive the expression for them. 10
   (b) Two sides of a square loop in the z = 0 plane are located at x = ± 0·6 m. and y = ± 0·6 m. There exists a uniform time varying magnetic field given by $\bar{B} = \left(0{\cdot}2\,\bar{a}_x - 0{\cdot}4\,\bar{a}_y + 0{\cdot}8\,\bar{a}_z\right)$ Cos (2000 t) Wb/m². If the total resistance of the loop is 1 K Ω find the current flowing through it. 10