S.E Sem 4 Electromagnetic Wave Theory 24/12/08
EXTC.

Con. 5069-08. RC-6155

(3 Hours) [Total Marks : 100

N.B. (1) Question No. 1 is **compulsory**.
(2) Attempt any **four** questions out of remaining **six** questions.
(3) Assume any **suitable** data if **necessary**.
(4) **Figures** to the **right** indicate **full** marks.

1. Explain the following : 20
   (a) Show that the divergence of flux density due to uniform point charge and uniform line charge is zero.
   (b) Prove that a static electric field is irrotational and the static magnetic field is solenoidal.
   (c) Biot Savart's Law.
   (d) State and explain Coulomb's Law.

2. (a) Given three charge distributions in free space 0·25 nC/m on the line x = 3, y = 2; – 0·2nC/m on the line z = 1, y = 3 and a point charge of 0·5 nC at origin. Find $\bar{D}$ ' at point (2, 3 4). 10
   (b) Derive an expression for Electric flux density $\bar{D}$ due to a uniform line charge density 'P_L' along z-axis. 10

3. (a) Given that $\bar{D} = \frac{2}{z^2}\left(yz\,\bar{a}_x + xz\,\bar{a}_y - 2xy\,\bar{a}_z \right) c/m^2$ in the region of free space that includes volume 2 < x, y, z > 3. Evaluate both the sides of divergence theorem. 10
   (b) Find the work done in moving a point charge Q = 5 μC from the origin to (2m, $\pi/4$, $\pi/2$) spherical coordinates in the field. 10

$$\bar{E} = +5e^{-r/4}\,\bar{a}_r + \frac{10}{r\sin\theta}\,\bar{a}_\phi \; V/m$$

4. (a) State and explain the boundary conditions for electrostatics. 10
   (b) If $V = \frac{60\sin\theta}{r^2}$ volts in free space and point 'P' is located at r = 3 m, θ = 60 and φ = 25°. 10
   Find—
   (1) V at P (2) $\bar{E}$ at P (3) $\frac{dV}{dN}$ at P (4) $\bar{a}_n$ at P (5) P_v at P .

5. (a) Using Biot Savart Law, find the magnetic field intensity at any point P due to a finite length conductor placed along z-axis. 10
   (b) An infinite long current filament is placed along z-axis. The magnetic field intensity at point P (3,4,0) is $10(-0{\cdot}8\bar{a}_x + 0{\cdot}6\bar{a}_y)$ A/m. 10
   Find the current through the filament.

6. (a) Derive an expression for the electric field intensity and electric potential due to a dipole. 10
   (b) $\bar{H} = H_x \cos(wt - By)\,\bar{a}_x$ exists within a dielectric of permittivity ∈, Estimate the corresponding displacement current density and then find the charge density and electric field corresponding to $\bar{H}$ field. 10

7. (a) Define Poynting vector. Obtain the integral form of Poynting theorem and explain each of the terms. 10
   (b) Explain the concept of conduction and convention currents. Moist soil has a conductivity of 10^{-3} s/m and $\varepsilon_r = 2{\cdot}5$. 10
   Find J_C and J_D where
   $E = 6{\cdot}0 \times 10^{-6} \sin 9{\cdot}0 \times 10^9\, t$ V/m.