

PART - B (5 × 16 = 80 Marks)

11. (a) (i) A point charge $Q_1 = 300 \mu\text{C}$ located at $(1, -1, -3)$ m experiences a force $F_1 = 8a_x - 8a_y + a_z$ (N) due to point charge Q_2 at $(3, -3, -2)$ m. Find the charge Q_2 . (8)
- (ii) Given that $\vec{D} = \left(\frac{5r^2}{4}\right) \vec{a}_r$ (C / m²) in spherical coordinates, evaluate both sides of divergence theorem for the volume enclosed by $r = 4$ m and $\theta = \frac{\pi}{4}$. (8)

OR

- (b) (i) Derive the expression for potential due to an electric dipole at any point P. Also find electric field intensity at the same point. (10)
- (ii) Two point charges, 1.5 nC at $(0, 0, 0.1)$ and -1.5 nC at $(0, 0, -0.1)$ are in free space. Treat the two charges as a dipole at the origin and find potential at $P(0.3, 0, 0.4)$. (6)
12. (a) (i) Find the magnetic field at the centre of a square loop, which carries a steady current I . Let R be the distance from centre to side. Find the field at the centre of a n -sided polygon, carrying a steady current I . Again, let R be the distance from the centre to any side. Find the formula in the limit n (number of sides) tends to infinity. (8)
- (ii) Find the magnetic field a distance h above the center of a circular loop of radius R , which carries a steady current I . (8)

OR

- (b) (i) Derive the Ampere's law. (8)
- (ii) Derive the expressions which mutually relate current density J , Magnetic field B and Magnetic vector potential A . (8)
13. (a) Derive the boundary relations for
- (i) E-field (8)
- (ii) H-field (8)

OR

- (b) A composite conductor of cylindrical cross section used in overhead line is made of a steel inner wire of radius "a" and an annular outer conductor of radius "b", the two having electrical contact. Evaluate the H-field within the conductors and the internal self-inductance per unit length of the composite conductor. (16)

14. (a) With necessary explanation, derive the Maxwell's equation in differential and integral forms. (16)

OR

- (b) (i) The conduction current flowing through a wire with conductivity $\sigma = 3 \times 10^7$ s/m and the relative permeability $\epsilon_r = 1$ is given by $I_c = 3 \sin \omega t$ (mA). $\omega = 10^8$ rad/sec, find the displacement current. (8)

- (ii) An electric field in a medium which is source free is given by $E = 1.5 \cos(10^8 t - \beta z) \bar{a}_x$ V/m. Find B, H and D. Assume $\epsilon_r = 1$, $\mu_r = 1$, $\sigma = 0$. (8)

15. (a) (i) Derive Wave Equation from Maxwell's Equations. (8)
(ii) Describe the concept of Plane Wave propagation in good conductors. (8)

OR

- (b) Explain with relevant expressions, the concept of reflection of plane waves by a perfect dielectric at both normal and oblique incidence. (16)