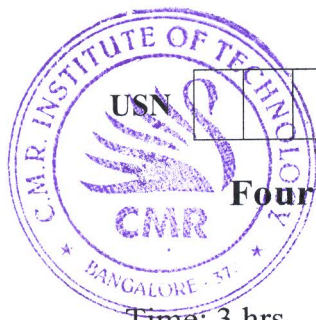


CBCS SCHEME



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15EE45

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024

Electromagnetic Field Theory

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- State and explain Coulomb's law of force between the two point charges. Also indicate the units of quantities in the force equation. (05 Marks)
 - Electric charge lies in the plane at $Z = -4\text{m}$ in the form of a square sheet prescribed by $-2 \leq x \leq 2\text{m}$, $-2 \leq y \leq 2\text{m}$. Charge density $\rho_s = 2(x^2 + y^2 + 16)^{3/2} \text{ nC/m}^2$. Determine electric field intensity 'E' at origin. (06 Marks)
 - Find: i) Electric field intensity ii) Electric flux density at the origin due to $Q_1 = 0.35\mu\text{C}$ at $(0, 4, 0)\text{m}$ and $Q_2 = -0.55\mu\text{C}$ at $(3, 0, 0)\text{m}$. (05 Marks)

OR

- Define electric field intensity. Obtain an expression for the electric field intensity (\vec{E}) due to an infinite line charge along Z axis having a uniform charge density $\rho_L \text{ C/m}$, using Coulomb's law. (08 Marks)
 - If $\vec{D} = 10e^{-2z}(\rho_a \bar{a}_\rho + \bar{a}_z) \text{ C/m}^2$, determine the flux of \vec{D} out of the entire surface of the cylinder $\rho = 1$, $0 \leq z \leq 1$, confirm the result by using divergence theorem. (08 Marks)

Module-2

- Find the work done in moving a charge $Q = 5\mu\text{C}$ in the electric field given by $E = 4x\bar{a}_x - 3y\bar{a}_y \text{ V/m}$ from
 - $(3, 0, 0)$ to $(0, 3, 0)\text{m}$ and from $(0, 0, 0)$ to $(0, 3, 0)\text{m}$
 - From $(3, 0, 0)$ to $(0, 3, 0)$ along the st-line path. (06 Marks)
 - With usual notation prove that $\vec{E} = -\nabla V$. (06 Marks)
 - A 15nC charge is located at origin in free space. Calculate V_p if P is located at $P(-2, 3, -1)$ and $V = 0$ at infinity. (04 Marks)

OR

- Derive an expression for energy expended in moving a point charge in an electric field. (06 Marks)
 - For a line charge $\rho_L = 10^{-9}/2 \text{ C/m}$ on the z-axis, find V_{AB} where A is $(2\text{m}, \pi/2, 0)$ and B is $(4\text{m}, \pi, 5\text{m})$. (05 Marks)
 - Evaluate the capacitance of two concentric spherical conducting shells of radius 'a' and 'b' with $b > a$. (05 Marks)

Module-3

- 5 a. Derive Poisson's and Laplace equation starting from point form of Gauss law and write the equation in three coordinate systems. (08 Marks)
- b. Determine whether or not the following potential field satisfy the Laplace equations:
- $V = x^2 - y^2 + z^2$
 - $V = r \cos \phi + z$
 - $V = r \cos \theta + \phi$
 - $V = 2x + 5y - z.$
- (08 Marks)

OR

- 6 a. Show that $\text{curl } \mathbf{H} = \mathbf{J}$ in a steady magnetic field. (08 Marks)
- b. Derive the expression for $\bar{\mathbf{H}}$ on the axis of a circular loop. (08 Marks)

Module-4

- 7 a. Derive the Lorentz force equation and mention the application of the solution. (06 Marks)
- b. Calculate the inductance of solenoid of 200 turns wound tightly on a cylindrical tube of length 60cm and diameter of 6cm. Given that medium is air. (04 Marks)
- c. Explain the terms magnetization and permeability. (06 Marks)

OR

- 8 a. Obtain the boundary conditions at the interface between two magnetic materials. (06 Marks)
- b. Derive the equation for force between two differential current carrying elements. (06 Marks)
- c. Define self inductance and mutual inductance with suitable formulae. (04 Marks)

Module-5

- 9 a. State Faraday's law and obtain point and integral form of electromagnetic induction. (06 Marks)
- b. Write a note on retarded potential. (06 Marks)
- c. For a electromagnetic wave, show that E and H is mutually perpendicular to each other. (04 Marks)

OR

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- 10 a. State and prove Poynting theorem. (06 Marks)
- b. Discuss the following i) Standing wave ii) Standing wave ratio. (06 Marks)
- c. Find the frequency at which conduction current density and displacement current density are equal in a medium with $\sigma = 2 \times 10^{-4} \text{ s/m}$ and $\epsilon_r = 81.$ (04 Marks)

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