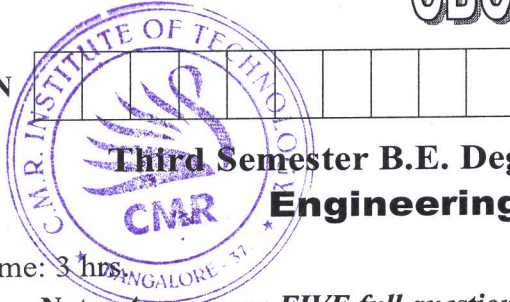


CBCS SCHEME

USN



17EC36

Third Semester B.E. Degree Examination, June/July 2023 Engineering Electromagnetics

Time: 3 hrs

Max. Marks: 100

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

Module-1

- 1 a. State and explain Coulomb's law of force between two point charges in vector form and mention the units. (06 Marks)
- b. A 2mc positive charge is located in vacuum at $P_1(3, -2, -4)\text{m}$ and $5\mu\text{c}$ negative charge is at $P_2(1, -4, 2)\text{m}$.
 - i) Find the vector force on the negative charge
 - ii) What is magnitude of force on the charge at P_1 ? (08 Marks)
- c. Show that the electric field intensity at a point due to 'n' number of point charge is given by
$$\vec{E} = \frac{1}{4\pi\epsilon_0} \sum_{i=1}^n \frac{q_i}{R_i^2} \hat{a}_{R_i} \text{ V/m} \quad (06 \text{ Marks})$$

OR

- 2 a. Derive an expression for the electric field intensity due to finite line charge. (08 Marks)
- b. A ring of radius 6m is placed in yz plane it is centered at origin. Find the electric field intensity at point $(8, 0, 0)$ the line charge density is $18\text{nc}/\mu$. Derived formula has to be used. (06 Marks)
- c. Define electric flux density. Explain Relationship between electric flux density and electric field intensity. (06 Marks)

Module-2

- 3 a. Prove that Gauss's law from Coulomb's law of point charge is placed in the origin of sphere. (08 Marks)
- b. Find the charge in the volume defined by $0 \leq x \leq 1$, $0 \leq y \leq 1$ and $0 \leq z \leq 1$. If volume charge density is $\rho_v = 40x^2y \mu\text{c}/\text{m}^3$. (06 Marks)
- c. Derive an expression for electric flux density of infinite line charge along Z axis in cylindrical surface. (06 Marks)

OR

- 4 a. Show that relationship between Electric field intensity and potential gradient $E = -\nabla V$. (06 Marks)
- b. An electrostatic field is given by $\vec{E} = \left(\frac{x}{2} + 2y\right)\hat{a}_x + 2x\hat{a}_y \text{ V/m}$. Find the work done in moving a point charge $Q = 20\mu\text{c}$ from $(4, 2, 0)$ to $(0, 0, 0)\text{m}$ along a straight line path. (08 Marks)
- c. Obtain the expression for point form of current continuity equation. (06 Marks)

Module-3

- 5 a. From point form of Gauss's law Derive an expression for Poisson's equation and Laplace's equation. (06 Marks)
- b. State and prove uniqueness theorem. (08 Marks)
- c. Verify that potential field given by below satisfies the Laplace's equation
i) $V = 2x^2 - 3y^2 + z^2$ ii) $V = x^2 - y^2 + z^2$ (06 Marks)

OR

- 6 a. Using Biot – Savart law. Obtain an expression for magnetic field intensity due to infinite long straight conductors. (08 Marks)
- b. State and prove Stoke's theorem. (06 Marks)
- c. A differential current element with $I = 4\text{amp}$ and $|d\vec{L}| = 10^{-3}\text{m}$ is located at point $(2, 0, 0)$ find the magnetic field intensity due to this current element at the point $(0, 1, 1)$ (06 Marks)

Module-4

- 7 a. Obtain the expression for Lorentz force equation. (06 Marks)
- b. A point charge of $Q = -1.2\text{c}$ has velocity $\vec{V} = (5\hat{a}_x + 2\hat{a}_y - 2\hat{a}_z)\text{m/s}$. Find the magnitude of the force executed on the charge. If
- i) $\vec{E} = -18\hat{a}_x + 5\hat{a}_y - 10\hat{a}_z\text{V/m}$
- ii) $\vec{B} = -4\hat{a}_x + 4\hat{a}_y + 3\hat{a}_z$
- iii) Both are present simultaneously (08 Marks)
- c. Derive an expression for the force between differential current elements. (06 Marks)

OR

- 8 a. Discuss the magnetic boundary conditions as applicable to \vec{B} and \vec{H} at the interface between two different magnetic materials. (10 Marks)
- b. Write a short note on forces on magnetic materials. (05 Marks)
- c. Derive an expression for inductance of a coaxial cable. (05 Marks)

Module-5

- 9 a. Starting from Faraday's law of electromagnetic induction, Derive an expression $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ (06 Marks)
- b. Derive the expression for displacement current density using Ampere's circuital law. (08 Marks)
- c. A circular conducting loop of radius 40cm lies in xy plane and has resistance of 20n. If the magnetic flux density in the region is given as $\vec{B} = 0.2\text{Cos } 500t \hat{a}_x + 0.75 \sin 400t \hat{a}_y + 12 \text{Cos } 314t \hat{a}_z \text{ T}$ Determine effective value of induced current in the loop. (06 Marks)

OR

- 10 a. List the Maxwell's equation in integral form and point form and derive the point form of Maxwell's equation for time varying fields. (10 Marks)
- b. State and prove Poynting theorem and show that the average power density (P_{avg}) (10 Marks)

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