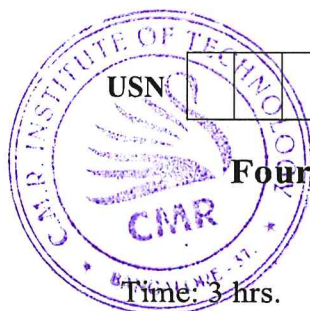


# CBCS SCHEME



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17EE45

## Fourth Semester B.E. Degree Examination, July/August 2022 Electromagnetic Field Theory

Time: 3 hrs.

Max. Marks: 100

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

### Module-1

- 1 a. Define a scalars and vectors. For a given vectors.  
 $\vec{A} = 6\vec{a}_x + 2\vec{a}_y + 6\vec{a}_z$  and  $\vec{B} = -2\vec{a}_x + 9\vec{a}_y - \vec{a}_z$
- i) Show that vectors  $\vec{A}$  and  $\vec{B}$  are perpendicular to each other.  
ii) Find  $\vec{A} \times \vec{B}$  and show  $\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$ . (08 Marks)
- b. Derive the relationship between rectangular and spherical coordinates. (06 Marks)
- c. Using surface integral obtain an expression for surface area of a sphere of radius " $r_1$ " meter. (06 Marks)

### OR

- 2 a. State and explain Coulomb's law in vector form. Mention the units involved in it. (07 Marks)
- b. State and prove Gauss law. (07 Marks)
- c. If  $\vec{D} = 2xy\vec{a}_x + 3yz\vec{a}_y + 4zx\vec{a}_z$  c/m<sup>2</sup>, how much electric flux passes through that portion of the plane at  $x = 3$ m for which  $-1 \leq y \leq 2$ m and  $0 \leq z \leq 4$ m. (06 Marks)

### Module-2

- 3 a. Show that the electric field intensity is equal to the gradient of a potential. (07 Marks)
- b. Determine the workdone in carrying a charge of 2C from B(1, 0, 1) to A(0.8, 0.6, 1) in an electric field  $\vec{E} = y\vec{a}_x + x\vec{a}_y + 2\vec{a}_z$  v/m along the short arc of circle  $x^2 + y^2 = 1$ ,  $z = 1$ . (07 Marks)
- c. Derive the expression for potential due to a point charge. (06 Marks)

### OR

- 4 a. With usual notations prove that  
$$\nabla \cdot \vec{J} = -\frac{\partial \rho_v}{\partial t}$$
 (07 Marks)
- b. Obtain the boundary conditions between conductor and free space. (08 Marks)
- c. A parallel plate capacitor of 8nF has an area of 1.51m<sup>2</sup> and separation of 10mm. What separation would be required to obtain the 10nF capacitance between the plates? (05 Marks)

### Module-3

- 5 a. Derive Poisson's and Laplace's equation. (06 Marks)
- b. State and explain uniqueness theorem. (08 Marks)
- c. Verify that the potential field given below satisfies the Laplace's equation.  
 $V = 2x^2 - 3y^2 + z^2$ . (06 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

- 6 a. Derive an expression for magnetic field intensity at a point due to an infinite long straight conductor carrying a current of I amperes along Z-axis. (10 Marks)
- b. Evaluate both sides of the Stoke's theorem for the field  $\vec{H} = 6xy \vec{a}_x - 3y^2 \vec{a}_y$  A/m and the rectangular path around the region,  $2 \leq x \leq 5$ ,  $-1 \leq y \leq 1$ ,  $z = 0$ . Let the positive direction of  $d\vec{s}$  be  $\vec{a}_z$ . (10 Marks)

**Module-4**

- 7 a. Derive an expression for the force between differential current elements. (07 Marks)
- b. Find the expression for force and torque on a closed circuit. (06 Marks)
- c. A point charge  $Q = 18\text{nC}$  has a velocity of  $5 \times 10^6$  m/s in the direction  $\vec{a}_v = 0.6\vec{a}_x + 0.75\vec{a}_y + 0.3\vec{a}_z$ . Calculate the magnitude of the force exerted on the charge by the field.
- i)  $\vec{E} = -3\vec{a}_x + 4\vec{a}_y + 6\vec{a}_z$  KV/m.
- ii)  $\vec{B} = -3\vec{a}_x + 4\vec{a}_y + 6\vec{a}_z$  mT.
- iii)  $\vec{B}$  and  $\vec{E}$  acting together. (07 Marks)

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OR

- 8 a. Obtain the magnetic boundary conditions. (10 Marks)
- b. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of length 60cm and of diameter 6cm, given that medium is air. Derive the expression used. (10 Marks)

**Module-5**

- 9 a. Write Maxwell's equations in point form and in integral form for time varying fields. (10 Marks)
- b. A circular loop of 10cm radius is located in x-y plane with magnetic field.  $\vec{B} = 0.5 \cos(377t)[3\vec{a}_x + 4\vec{a}_z]$  T. Calculate voltage induced in a loop. (10 Marks)

OR

- 10 a. Starting from Maxwell's equations obtain the general wave equations in electric and magnetic fields. (10 Marks)
- b. The magnetic field intensity of uniform plane wave in air is 20A/m in  $\vec{a}_y$  direction. The wave is propagating in the  $\vec{a}_z$  direction at an angular frequency of  $2 \times 10^9$  rad/sec. Find:
- i) Phase shift constant
- ii) Wavelength
- iii) Frequency
- iv) Amplitude of electric field intensity. (10 Marks)

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