

# CBCS SCHEME



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17EE45

## Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024 Electromagnetic Field Theory

Time: 3 hrs.

Max. Marks: 100

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

### Module-1

- Define scalar and vector. Two points A(2, 2, 1) and B(3, -4, 2) are given in the Cartesian system obtain the vector from A to B and a unit vector directed from A to B. (06 Marks)
  - Define divergence of a vector. What do positive and negative divergences represent. (04 Marks)
  - Derive the relationship between cylindrical and spherical coordinate systems. (10 Marks)

OR

- State and explain coulomb's law of force between the two point charges. (05 Marks)
  - Define electric field intensity (E). Find an expression for electric field intensity due to N different point charges. (07 Marks)
  - State and explain Gauss law in electrostatics. (08 Marks)

### Module-2

- Define the following :
    - Potential difference and potential
    - Potential gradient.(06 Marks)
  - Show that energy density in the electrostatic field is given by  $\frac{1}{2} \vec{D} \cdot \vec{E} \text{ J/m}^3$ . (08 Marks)
  - Given that the potential field is  $V = 2x^2y - 5z$ . Find the potential, electric field intensity and volume charge density at point P(-4, 3, 6). (06 Marks)

OR

- With necessary relations, define current and current density. (04 Marks)
  - Explain the boundary conditions for a boundary between two di-electric materials. (08 Marks)
  - Derive an expression for the capacitance per unit length of a two wire transmission line. (08 Marks)

### Module-3

- Derive Poisson's and Laplace equations starting from point form of Gauss law. (07 Marks)
  - Verify that the potential field given below satisfies the Laplace's equation :  
 $V = 2x^2 - 3y^2 + z^2$ . (06 Marks)
  - State and prove Uniqueness Theorem. (07 Marks)

OR

- State and explain Biot-Savart's law. (07 Marks)
  - State and explain Stoke's theorem. (06 Marks)
  - Derive an expression for vector magnetic potential. (07 Marks)

**Module-4**

- 7 a. Derive an expression for the force between differential current elements. (10 Marks)
- b. A point charge of  $Q = -1.2\text{C}$  has velocity  $\mathbf{v} = (5\bar{a}_x + 2\bar{a}_y - 3\bar{a}_z)$  m/s. Find the magnitude of the force exerted on the charge if,
- i)  $\bar{\mathbf{E}} = -18\bar{a}_x + 5\bar{a}_y - 10\bar{a}_z$  v/m
- ii)  $\bar{\mathbf{B}} = -4\bar{a}_x + 4\bar{a}_y - 3\bar{a}_z$  T
- iii) Both are present simultaneously. (10 Marks)

**OR**

- 8 a. Derive the boundary conditions at the interface between two magnetic materials of different permeabilities. (10 Marks)
- b. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of 6cm diameter. The length of the tube is 60cm and the solenoid is in air. (03 Marks)
- c. Define mutual inductance. Derive an expression for mutual inductance of two different coils. (07 Marks)

**Module-5**

- 9 a. Explain briefly Faraday's law and displacement current for time varying fields. (08 Marks)
- b. In a given lossy dielectric medium, conduction current density  $J_C = 0.02 \sin 10t$  (A/m<sup>2</sup>). Find the displacement current density if  $\sigma = 10^3$  s/m and  $\epsilon_r = 6.5$ . (05 Marks)
- c. Write Maxwell's equations in point form and in integral form for time varying fields. (07 Marks)

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**OR**

- 10 a. Discuss the propagation of uniform plane waves in a lossless medium. (07 Marks)
- b. Define poynting vector and explain the power flow associated with it. (07 Marks)
- c. A 300MHz uniform plane wave propagates through fresh water for which  $\sigma = 0$ ,  $\mu_r = 1$  and  $\epsilon_r = 78$ . Calculate :
- i) The attenuation constant
- ii) The phase constant
- iii) The wave length. (06 Marks)

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