

# CBCS SCHEME

17EC36



## Third Semester B.E. Degree Examination, Dec.2023/Jan.2024 Engineering Electromagnetic

Time: 3 hrs.

Max. Marks: 100

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

### Module-1

- State Coulomb's law of force between two point charges in vector form. Also derive an expression for the total force due to 'n' number of point charges. (08 Marks)
  - Obtain an expression for electric field intensity at a given point due to 'n' number of point charges. (04 Marks)
  - Four point charges each of  $10\mu\text{c}$  are placed in free space at the points (1, 0, 0), (-1, 0, 0), (0, 1, 0) and (0, -1, 0)m, respectively. Determine the force on a point charge of  $30\mu\text{c}$  located at a point (0, 0, 1)m. (08 Marks)

OR

- Derive an expression for electric field intensity at a given point due to infinite line charge. (08 Marks)
  - Define electric flux density. Derive the equation for flux density due to point and line charge. (05 Marks)
  - A line charge density  $\rho_L = 24\text{nc/m}$  is located in free space on the line  $y = 1$  and  $z = 2\text{m}$ .
    - Find  $\vec{E}$  at the point P(6, -1, 3)
    - What point charge  $Q_A$  should be located at A(-3, 4, 1) to make y component of total  $\vec{E}$  zero at point P. (07 Marks)

### Module-2

- State and prove Gauss law. Give its mathematical representation. (08 Marks)
    - State and prove divergence theorem.
  - The flux density within the cylindrical volume bounded by  $r = 5\text{m}$ ,  $z = 0$  and  $z = 2\text{m}$  is given by  $\vec{D} = 30e^{-r} \vec{a}_r - 2z \hat{a}_z \text{ c/m}^2$ . What is the total outward flux crossing the surface of the cylinder? (12 Marks)

OR

- What is potential? Also derive the expression for potential due to a point charge and given the concept of absolute potential. (08 Marks)
  - Find the work done in moving a point charge of  $5\mu\text{c}$  in the electric field defined by  $\vec{E} = 4x \hat{a}_x - 3y \hat{a}_y \text{ V/m}$ .
    - From (3, 0, 0) to (0, 0, 0) and from (0, 0, 0) to (0, 3, 0)
    - From (3, 0, 0) to (0, 3, 0) along the straight line path joining the two points. (12 Marks)

**Module-3**

- 5 a. Derive Laplace's and Poisson's equations. (06 Marks)  
 b. State and prove uniqueness theorem. (06 Marks)  
 c. In a free space,  $\rho_v = \frac{200\epsilon_0}{r^{2.4}}$   
 i) Use Poisson's equation, to find 'V' as a function of r, if it is assumed that  $r^2 E_r$  is  $\rightarrow 0$  as  $r \rightarrow 0$  and  $V \rightarrow 0$  as  $r \rightarrow \infty$ . Use spherical co-ordinate system.  
 ii) Find potential 'V' as a function of 'r' using Gauss's law and line integral. (08 Marks)

**OR**

- 6 a. State and prove Biot-Savart law in its integral form. (08 Marks)  
 b. Derive the equations for scalar and vector magnetic potentials. (04 Marks)  
 c. Given  $\vec{H} = 20r^2 \hat{a}_\phi$  A/m.  
 i) Determine the current density  $\vec{J}$   
 ii) Also determine the total current that crosses the surface  $r = 1$  m,  $0 < \phi < 2\pi$  and  $z = 0$  (in cylindrical co-ordinates). (08 Marks)

**Module-4**

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

**OR**

- 8 a. Derive the tangential and normal magnetic boundary conditions. Also derive the equation for component of  $\vec{B}$  at boundary. (10 Marks)  
 b. In region 1, as shown in Fig.Q8(b),  $\vec{B}_1 = 1.2\hat{a}_x + 0.8\hat{a}_y + 0.4\hat{a}_z$  Tesla. Determine  $\vec{B}_2$  and  $\vec{H}_2$  in other medium and also calculate the angles made by the fields with the normal. (10 Marks)

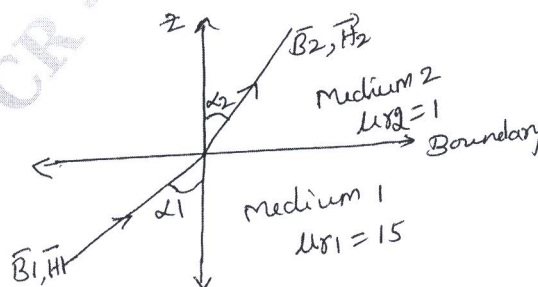


Fig.Q8(b)

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(10 Marks)



**Module-5**

- 9 a. State and explain Faraday's law and Lenz's law. Also explain the physical significance of displacement current with proper derivation. (10 Marks)
- b. List the Maxwell's equations in point and integral form for static fields and time varying fields. Mention their significance. (10 Marks)

**OR**

- 10 a. Derive the general wave equations using the Maxwell's equations. (10 Marks)
- b. State and explain Poynting theorem. A 9375MHz uniform plane wave is propagating in polystyrene. If the amplitude of the electric field intensity is 20V/m and the material is assumed to be lossless, find :
- Attenuation constant
  - Phase constant
  - Wavelength in polystyrene
  - Velocity of propagation
  - Intrinsic impedance
  - Propagation constant
  - Amplitude of the magnetic field intensity.
- For polysterem,  $\mu_r = 1$ ,  $\epsilon_r = 2.56$ . (10 Marks)

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