

# CBCS SCHEME

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15EC36

## Third Semester B.E. Degree Examination, June/July 2018 Engineering Electromagnetics

Time: 3 hrs.

Max. Marks: 80

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

### Module-1

- Define electric field intensity and flux density and also establish the relationship between them. (04 Marks)
  - State and explain Coulomb's law of force between two point charges. (06 Marks)
  - Two uniform line charges of densities  $4 \text{ nC/m}$  and  $6 \text{ nC/m}$  lying in  $x = 0$  plane at  $y = 5 \text{ m}$  and  $y = -6 \text{ m}$  respectively. Find electric field intensity at  $P(4, 0, 5) \text{ m}$ . (06 Marks)

OR

- Derive an expression for electric field intensity due to infinite line charge. (08 Marks)
  - A volume charge density  $\rho_v = \frac{5k}{r}$ , where  $r \neq 0$ ,  $k = \text{constant}$  exists within a sphere of radius  $\frac{a}{2}$ . Determine the magnitude of point charge placed at origin which will produce the same electric field at  $r = \frac{a}{2}$ . (08 Marks)

### Module-2

- Derive the Maxwell's first equation in electrostatics. (04 Marks)
  - Derive the expression for continuity of current. (06 Marks)
  - Find the total charge in a volume defined by six planes for which  $1 \leq x \leq 2$ ;  $2 \leq y \leq 3$ ;  $3 \leq z \leq 4$ . If  $\vec{D} = [4x\hat{a}_x + 3y^2\hat{a}_y + 2z^3\hat{a}_z] \text{ C/m}^2$ . (06 Marks)

OR

- Briefly explain Gauss's divergence theorem. (06 Marks)
  - Obtain an expression for the energy expended in moving a point charge in an electric field. (06 Marks)
  - Let  $V = \frac{\cos 2\phi}{r}$  in free space in cylindrical system. Find  $\vec{E}$  at  $B(2, 30^\circ, 1)$ . (04 Marks)

### Module-3

- With the usual notations, deduce the Poisson's and Laplace's equation from the Maxwell's first equation. (06 Marks)
  - Determine whether or not the following vector represents a possible electric field.  
 $\vec{E} = 5 \cos z \hat{a}_r \text{ V/m}$ . (04 Marks)
  - Prove that the line integral of magnetic field intensity  $\vec{H}$  around a closed path is exactly equal to current 'I' enclosed by that path. (06 Marks)

OR

- 6 a. Solve Laplace's equation to determine the capacitance of a coaxial cable when the inner radius is 'a' and outer radius is 'b' respectively. (08 Marks)
- b. State and explain 'stokes theorem'. (04 Marks)
- c. Given the vector magnetic potential  $\vec{A} = x^2 \hat{a}_x + 2yz \hat{a}_y + (-x^2) \hat{a}_z$ . Find magnetic flux density. (04 Marks)

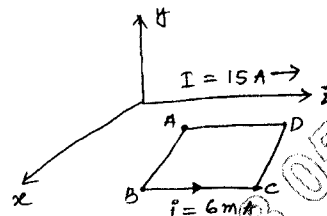
**Module-4**

- 7 a. Derive Lorentz force equation and mention the application of solution. (05 Marks)
- b. A point charge  $Q = -1.2C$  has velocity  $\vec{V} = (5\hat{a}_x + 2\hat{a}_y - 3\hat{a}_z)$  m/s. Find the magnitude of 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. (06 Marks)
- c. Briefly explain force between differential current elements. (05 Marks)

OR

- 8 a. Discuss the magnetic boundary condition at the interface between two different magnetic materials. (05 Marks)
- b. Briefly explain potential energy and forces on magnetic materials. (05 Marks)
- c. A rectangular loop of wire in free space joins A(1, 0, 1), B (3, 0, 1) to C(3, 0, 4) and D (1, 0, 4) to A. The wire carries a current of 6mA flowing in  $\hat{a}_z$  direction from B to C. A filamentary current of 15A flows along the entire z-axis in the  $\hat{a}_z$  direction as shown in Fig.Q.8(c). Find: i) Force on side BC ii) Force on side AB iii) Total force on loop. (06 Marks)

Fig.Q.8(c)

**Module-5**

- 9 a. State and explain Faraday's law in point and integral form. (06 Marks)
- b. Derive Ampere's circuit law in point form and integral form suitable for Time-varying fields. (07 Marks)
- c. Find the angular frequency at which the conduction current and displacement current are equal in medium with  $\sigma = 5.6 \times 10^{-9}$  S/m and  $\epsilon_r = 40$ . (03 Marks)

OR

- 10 a. State and prove Poynting theorem. (06 Marks)
- b. Briefly explain skin depth and skin effect. (05 Marks)
- c. A 300MHz uniform plane wave propagation through fresh water for which  $\sigma = 0$ ,  $\mu_r = 1$  and  $\epsilon_r = 78$ . Calculate:
- i) Attenuation constant
- ii) Phase constant
- iii) Wave length
- iv) Intrinsic impedance. (05 Marks)

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