CBCS SCHEME

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17EC36

Third Semester B.E. Degree Examination, Jan./Feb. 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. **(06 Marks)**

b. Q_1 and Q_2 are the point charges located at (0, -4, 3) and (0, 1, 1). If Q_1 is 2nC, determine Q_2 such that force on a test charge at (0, -3, 4) has no z-component. **(07 Marks)**

c. Derive the expression for electric field intensity due to infinite line charge. **(07 Marks)**

OR

2 a. Define electric field Intensity. Derive an expression for electric field intensity due to 'n' number of point charges. **(06 Marks)**

b. Two uniform line charges of density 4n c/m and 6n c/m lie in x = 0 plane at y = +5m and -6m respectively. Find $\bar{E}$ at P(4, 0, 5)m. **(07 Marks)**

c. Define Electric flux and Electric flux density. Determine the flux crossing $\phi = \pi/4$ half plane defined by $0 \le r \le 3$ and $2 \le z \le 4$, given that $\bar{D} = \frac{r^2 z^2}{3}\cos\phi \cdot \bar{a}\phi$. **(07 Marks)**

Module-2

3 a. State and prove Maxwell's first equation. **(06 Marks)**

b. Given that $\bar{D} = \frac{5r^2}{4}\bar{a}_r \; c/m^2$. Evaluate both sides of divergence theorem for the volume enclosed by r = 4m and $\theta = \pi/4$. **(07 Marks)**

c. Determine the potential difference between two points due to a point charge at origin. **(07 Marks)**

OR

4 a. State and explain Gauss's law. **(06 Marks)**

b. Given that $V = \frac{\text{Cos}2\phi}{r}$ in free space

i) Find $\bar{E}$ at p(2, 30°, 1).

ii) Find volume charge density at A(0.5, 60°, 1). **(07 Marks)**

c. Find an expression establishing the relationship between electric field and potential gradient. **(07 Marks)**

Module-3

5 a. State and prove uniqueness theorem. **(08 Marks)**

b. If the field of a region in space is given by $\bar{E} = 5\cos z \; \bar{a}_z \; v/m$, is the region free of charge. **(06 Marks)**

c. Obtain the expression for magnetic field intensity at a point due to a current carrying straight conductor of finite length. **(06 Marks)**

OR

6 a. State and prove Stoke's theorem. **(08 Marks)**

b. Discuss the concept of vector magnetic potential and derive an expression for it. **(06 Marks)**

c. Given the vector magnetic potential $\bar{A} = x^2\bar{a}_x + 2yz\,\bar{a}_y + (-x^2)\bar{a}_z$, find magnetic flux density. **(06 Marks)**

Module-4

7 a. Derive an equation for magnetic force between two differential current elements. **(06 Marks)**

b. Define magnetization and permeability and explain with relevant expressions. **(06 Marks)**

c. Find the normal component of the field traversed from medium 1 to medium 2 having $\mu_{r_1} = 2.5$, $\mu_{r_2} = 4$ given that $\bar{H}_1 = -30\bar{a}_x + 50\bar{a}_y + 70\bar{a}_z$ v/m. **(08 Marks)**

OR

8 a. State and explain Lorentz force equation. **(06 Marks)**

b. Briefly explain the forces on magnetic materials. **(06 Marks)**

c. A current element $I_1 dl_1 = 10^{-4}\ \bar{a}_z$ Am is located at (2, 0, 0) and other element $I_2\, dl_2 = 10^{-6}\ (\bar{a}_x - 2\bar{a}_y + 3\bar{a}_z)$ Am is located at (-2, 0, 0). Both are in free space. Find:

i) Force exerted on $I_2\, dl_2$ by $I_1 dl_1$

ii) Force exerted on $I_1 dl_1$ by $I_2 dl_2$. **(08 Marks)**

Module-5

9 a. What is uniform plane wave? Derive an expression of uniform plane wave travelling in free space. **(07 Marks)**

b. Starting from equation of Faraday's law, obtain the point form of Maxwell's equation. Concerning spatial derivative of $\bar{E}$ and time derivative of $\bar{H}$ or prove that $\nabla \times \vec{E} = -\mu \frac{\partial \vec{H}}{\partial t}$. **(07 Marks)**

c. Given $\bar{H} = Hm\, e^{j(\omega t + \beta z)}\bar{a}_x$ A/m in free space. Find $\bar{E}$. **(06 Marks)**

OR

10 a. State and prove Poynting's theorem. **(07 Marks)**

b. Define displacement current density starting from the equation of ampere's circuital law, derive $\nabla \times \bar{H} = \bar{J}_C + \bar{J}_D$. **(07 Marks)**

c. Calculate the intrinsic impedance η, the propagation constant γ, and wave velocity v for a conducting medium in which $\sigma = 58$Ms/m, $\mu_r = 1$, $\epsilon_r = 1$ at a frequency of 100MHz. **(06 Marks)**

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