CBCS SCHEME

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15EE45

Fourth Semester B.E. Degree Examination, June/July 2023
Electromagnetic Field Theory

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Given point P(-2, 6, 3) and vector $A = y\bar{a}x + (x + z)\bar{a}y$. Express P and A in cylindrical and spherical co-ordinates. Evaluate A and P in the Cartesian, Cylindrical and Spherical systems. **(10 Marks)**

b. Derive the relationship between rectangular and cylindrical co-ordinates. **(06 Marks)**

OR

2 a. Derive the expression for the electric field due to infinite sheet of charge placed in xy – plane having surface charge density of ρ_s c/m^2. **(07 Marks)**

b. Find $\overline{D}$ in Cartesian co-ordinate system at point P(6, 8, -10) due to
i) a point charge of 40mC at the origin.
ii) a uniform ∞ line charge of $\rho_L = 40$ μc/m on the Z – axis
iii) a uniform ∞ surface charge of density $\rho_s = 57.2$ μc/m^2 on the plane x = 12m. **(09 Marks)**

Module-2

3 a. Derive an equation for the potential at a point, due to an infinite line charge. **(06 Marks)**

b. Find the field and volume charge density at P(0.5, 1.5, 1)m in free space given the potential field as under i) $V = 2x^2 - y^2 - z^2$ volt ii) $V = 6\rho\phi z$ volt. **(10 Marks)**

OR

4 a. With usual notation, derive the expression

$$\nabla . J = -\frac{\partial \rho v}{\partial t}.$$ **(09 Marks)**

b. An electric field strength 3V/m in air enters a dielectric, the orientations of electric fields with respect to boundary in air and dielectric are 30° and 60° respectively. Find the relative permittivity of the dielectric also find the field strength in dielectric. **(07 Marks)**

Module-3

5 a. Using Laplace equations, derive the expressions for the capacitance of a coaxial cable. **(08 Marks)**

b. Write Laplace equation in explicit form in cylindrical co-ordinate system. **(08 Marks)**

OR

6 a. Using Ampere's Circuital law find $\overline{H}$ due to a co-axial cable carrying current I and hence plot the variation of $\overline{H}$ against r. **(10 Marks)**

b. Using Biot – Savart's law find the value of magnetic flux density at the point P for the current circuit shown in Fig. Q6(b). **(06 Marks)**

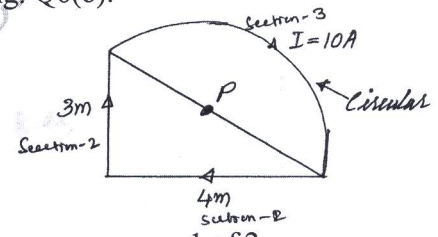

Fig.Q6(b)

Module-4

7 a. Derive an equation for the magnetic force between the two differential current elements. **(08 Marks)**

b. Find the magnetic field due to a small circular loop of radius "a" carrying current I, at a distance "r" from the loop. "r" is very large as compared to dimensions of the loop as shown in Fig. Q7(b). **(08 Marks)**

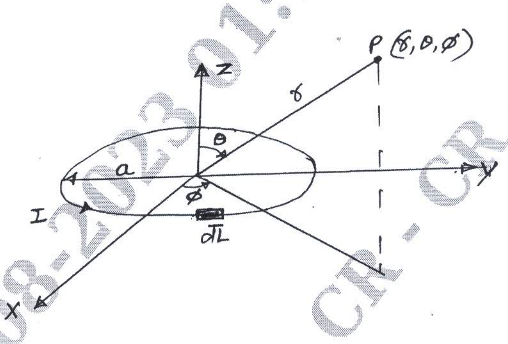

Fig.Q7(b)

OR

8 a. If $\overline{B} = 0.05\,x\,\bar{a}_y$ T in a material for which $X_m = 2.5$. Find

i) μr ii) μ iii) $\overline{H}$ iv) M v) J vi) Jb. **(08 Marks)**

b. Derive the expression for self – inductance of a co-axial cable. **(08 Marks)**

Module-5

9 a. Explain the concept of retarded potentials. Derive the expressions for the same. **(08 Marks)**

b. Given $\overline{E} = E_m \sin(wt - \beta x)\,\bar{a}_y$ in free space, find $\overline{D}$, $\overline{B}$ and $\overline{H}$, sketch $\overline{E}$ and $\overline{H}$ at t = 0. **(08 Marks)**

OR

10 a. Derive wave equation in $\overline{E}$ and $\overline{H}$ for a conducting medium. **(08 Marks)**

b. Derive an expression for loss – tangent in an insulating material and mention the practical significance of the same. **(08 Marks)**

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