CBCS SCHEME

USN | | | | | | | | | |

15EC36

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

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. State vector form of Coloumb's law of force between two point charges and indicate the units of the quantities in the equation. **(04 Marks)**

b. Let a point charge $Q_1 = 25nC$ be located at $A(4, -2, 7)$ and charge $Q_2 = 60nC$ be at $B(-3, 4, -2)$. Find $\vec{E}$ at $C(1, 2, 3)$ and find the direction of $\vec{E}$. **(10 Marks)**

c. Define Electric Field intensity due to number of point charge in a vector form. **(02 Marks)**

OR

2 a. Derive an expression for the electric field intensity due infinite line charge. **(06 Marks)**

b. Define electric flux density. Find $\vec{D}$ in Cartesian co-ordinate system at a point $p(6, 8, -10)$ due to a point charge of 40mC at the origin and a uniform line charge of $\rho_L = 40\mu C/m$ on the z-axis. **(10 Marks)**

Module-2

3 a. State and prove Gauss law and derive first Maxwell's equations from it. **(05 Marks)**

b. Given a 60 μc point charge located at the origin. Find the total electric flux passing through the closed surface defined by $\rho = 26$ cm and $z = \pm 26$ cm. **(04 Marks)**

c. State and prove the Divergence theorem. **(05 Marks)**

d. Given the electric flux density $D = 0.3r^2\hat{a}_r$ nc/m^2 in free space. Find E at the point $P(r = 2, \theta = 25°, \phi = 90°)$. **(02 Marks)**

OR

4 a. Prove that the work done in moving a charge in the electric field is

$$W = -Q\int_{\text{initial}}^{\text{final}} E.d\ell.$$ **(06 Marks)**

b. Calculate the work done in moving a 4C charge from B(1, 0, 0) to A(0, 2, 0) along the path $y = 2 - 2x$, $\tau = 0$ in the field $E = (5x\, a_x + 5y\, a_y)$ V/m. **(05 Marks)**

c. Show that $\nabla . J = -\dfrac{\partial \rho_v}{\partial t}$ with usual notations. **(05 Marks)**

Module-3

5 a. State and explain Biot-Savart's law. **(05 Marks)**

b. Two parallel conducting discs are separated by distance 5mm at $z = 0$ and $z = 5$mm. If $v = 0$ at $z = 0$ and $v = 100v$ at $z = 5$mm, find the charge densities on the discs. **(05 Marks)**

c. Using Poisson's equation obtain the expression for the junction potential in a p-n junction. **(06 Marks)**

OR

6 a. Derive Laplace and Poisson's equation starting from the Gauss's law and also write Laplace's equation in Cartesian, cylindrical and spherical coordinate system. **(08 Marks)**

b. Evaluate both sides of the Stoke's theorem for the field $\overline{H} = 6xy\ \hat{a}x - 3y^2\hat{a}y$ A/m and the rectangular path around the region $2 \le x \le 5$, $-1 \le y \le 1$, $z = 0$ let the positive direction of $\overline{ds}$ be $\hat{a}_z$. **(08 Marks)**

Module-4

7 a. The field $B = (-2a_x + 3a_y + 4\hat{a}_z)$mT is present in free space. Find the vector force exerted on a straight wire carrying a current of 12A in the a_{AB} direction. Given A(1, 1, 1,) and B(2, 1, 1). **(04 Marks)**

b. Two differential current elements , $I_1\Delta L_1 = 3\times10^{-6}$ A-m at $P_1(1, 0, 0)$ and $I_2\Delta L_2 = 3\times10^{-6}(-0.5\hat{a}_x + 0.4\hat{a}_y + 0.3\hat{a}_z)$ A-m at $P_2(2, 2, 2)$ are located in free space. Find the vector force exerted on $I_2\Delta L_2$ by $I_1\Delta L_1$. **(06 Marks)**

c. Find the magnetization in a magnetic material where

i) $\mu = 1.8\times10^{-5}$ H/m and H = 120 A/m.

ii) $\mu_r = 22$, there are 8.3×10^{22} atoms/m, and each atom has a dipole moment of 4.5×10^{-27} A/m^2.

iii) $B = 300\,\mu T \times \chi_m = 15$. **(06 Marks)**

OR

8 a. Derive the Magnetic Boundary Condition? **(06 Marks)**

b. Let the permittivity is 5μH/m in the region 1 where x < 0 and 20 μH/m in the region 2 where x > 0 , and if $H = (300a_x - 400a_y + 500\hat{a}_z)$ A/m and if there is a surface current density $K = (150\hat{a}_y - 200\hat{a}_z)$ A/m at x = 0.

Find i) $|H_{t_1}|$ ii) $|H_{N_1}|$ iii) $|H_{t_2}|$ iv) $|H_{N_2}|$. **(06 Marks)**

c. Derive the expression for the energy density in a magnetic field. **(04 Marks)**

Module-5

9 a. Explain Displacement current density and conduction current density. **(04 Marks)**

b. List Maxwell's equations for steady and time varying fields in

i) Point form ii) Integral from. **(06 Marks)**

c. Do the fields $\vec{E} = E_m \sin x \sin t\,\hat{a}_y$ and $\vec{H} = \frac{E_m}{\mu_o}\cos x \cos t\,\hat{a}_z$ satisfy Maxwell's equations? **(06 Marks)**

OR

10 a. What is Forward travelling wave and Backward travelling wave in free space? **(02 Marks)**

b. A uniform plane wave in free space is given by $E_s = 200\,\underline{|30^\circ} \cdot e^{-j250z}\,\hat{a}_x$ V/m.

Find β, w, f, λ, η, $|\vec{H}|$. **(06 Marks)**

c. State and prove Poynting theorem. **(08 Marks)**

* * * * *