CBCS SCHEME

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18EC55

Fifth Semester B.E. Degree Examination, June/July 2023
Electromagnetic Waves

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Derive the expression for Electric Field due to line charge of infinite length. **(08 Marks)**

b. Find the force on 100 μc charge at (0, 0, 3)m , if four like charges of 20 μc are located on the x and y axis at ±4m. **(06 Marks)**

c. Determine Electric Field at origin due to charge at 6.44×10^{-9}C located at (4, 2, –3)m in Cartesian coordinate system. **(06 Marks)**

OR

2 a. A charge lies in the Z = –3m plane in the form of a square sheet defined by $-2 \le x \le 2$, $-2 \le y \le 2$ m with $\rho_s = 2(x^2 + y^2 + 9)^{3/2}$ nc. Find Electric field at origin. **(07 Marks)**

b. Three negative charges $Q_1 = -1$ μC , $Q_2 = -2$ μC , $Q_3 = -3$ μC are placed at the corners of an equilateral triangle. If length of each side is 1m, find magnitude and direction of EF at a point bisecting line between the charge Q_2 and Q_3. **(08 Marks)**

c. Derive the expression for Electric field intensity due to several point charges. **(05 Marks)**

Module-2

3 a. A charge Q is uniformly distributed in a square ring of side *l*. Find E and V at centre of the ring. **(08 Marks)**

b. Determine work done in carrying a charge of – 2C from (2, 1, –1) to (8, 2, –1) in Electric field $E = y\hat{a}_x + x\hat{a}_y$ considering the path along parabola $x = 2y^2$. **(05 Marks)**

c. State and prove Gauss divergence theorem. **(07 Marks)**

OR

4 a. A point charge Q = 90 μC is located at origin and these are two uniformly surface charge density distribution – 8 μC/m² at r = 1m and 4.5 μC/m² at r = 2. Find $\overline{D}$ everywhere. **(08 Marks)**

b. Given $D = 5r\ \hat{a}_r$ C/m². Determine whether divergence theorem holds good for shell region enclosed by spherical surface at r = a and r = b(b > a) centred at origin. **(07 Marks)**

c. Find the potential and volume charge density at P(0.5, 1.5, 1)m in free space given $V = 2x^2 - y^2 - z^2$. **(05 Marks)**

Module-3

5 a. Let $V = A \ln\left[\frac{B(1-\cos\theta)}{1+\cos\theta}\right]$

i) Show that V satisfies Laplace equation in spherical coordinates.

ii) Find A and B, so that V = 100 V and E = 500 at r = 5cm, θ = 90, ϕ = 60°. **(08 Marks)**

b. State and explain strokes theorem. **(04 Marks)**

c. Determine whether or not the following potential satisfy Laplace equation :

i) $V = r\cos\phi + z$ ii) $V = x^2 - y^2 + z^2$ **(08 Marks)**

OR

6 a. Find the magnetic field intensity at P for the Fig.Q6(a).

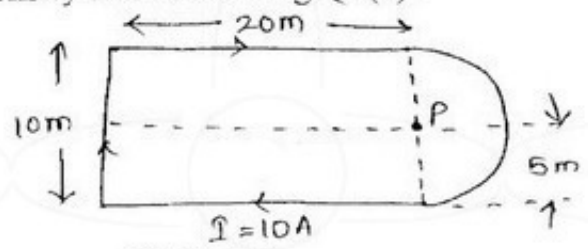

Fig.Q6(a) **(08 Marks)**

b. There exist a potential of V = –2.5V on the conductor of 0.02m and V = 15V at r = 0.35m. Determine E and D by solving Laplace equation in spherical coordinates. **(07 Marks)**

c. If the magnetic field intensity in region $H = (3y - 2)\hat{a}_z + 2x\hat{a}_y$. Find current density. **(05 Marks)**

Module-4

7 a. For region1, $\mu_1 = 4\mu$ H/m and for region2, $\mu_2 = 6\mu$ H/m. The regions are separated by Z = 0 plane. The surface current density at the boundary is $K = 100\hat{a}_x$ A/m. Find B_2 if $B_1 = 2\hat{a}_x - 3\hat{a}_y + \hat{a}_z$ mT for Z = 0. **(08 Marks)**

b. A circular conducting loop of radius 40cm lies in xy plane and has a resistance of 20Ω. If magnetic flux density is $B = 0.2\cos(500t)\hat{a}_x + 0.75\sin(400t)\hat{a}_y + 1.2\cos(314t)\hat{a}_z$. Find induced current in Loop. **(07 Marks)**

c. Explain Lorentz force equation. **(05 Marks)**

OR

8 a. A conductor of length 2.5m in Z = 0 and x = 4m carries a current of 12A in $-\hat{a}_y$ direction. Calculate uniform flux density in region, if force on the conductor is 12×10^{-2} N in direction by $\left[\frac{-\hat{a}_x + \hat{a}_z}{\sqrt{2}}\right]$ **(07 Marks)**

b. Explain Magnetization and Permeability. **(07 Marks)**

c. Explain force between differential current elements with equation. **(06 Marks)**

Module-5

9 a. Given $H = H_m e^{j(\omega t - \beta z)}\hat{a}_x$ A/m in free space. Find E. **(07 Marks)**

b. Derive the wave equation for vector E and H field in conducting medium. **(08 Marks)**

c. Prove that $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$. **(05 Marks)**

OR

10 a. Discuss the propagation of uniform plane wave in good conductor and explain skin depth. **(08 Marks)**

b. Determine $\alpha, \beta, \gamma, v, \lambda, \eta$ for damp soil at frequency of 1 MHz given that $\varepsilon_r = 12$, $\mu_r = 1$, and $\sigma = 20$m ℧/m. **(05 Marks)**

c. Find the Amplitude of displacement current density in free space within large power distribution

$H = 10^6\cos(377t + 1.256\times10^{-6}z)\hat{a}_y$ **(07 Marks)**

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