CBCS SCHEME

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17EC36

Third Semester B.E. Degree Examination, Aug./Sept. 2020
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 in vector form. **(05 Marks)**

b. Define electric field intensity and electric flux density. **(05 Marks)**

c. Let a point charge $Q_1 = 25nC$ be located at $P_1(4, -2, 7)$ and a charge $Q_2 = 60nC$ be at $P_2(-3, 4, -2)$.

i) If $\in = \in_0$, find electric field intensity (E) at $P_3(1, 2, 3)$

ii) At what point on the Y axis is $E_X = 0$. **(10 Marks)**

OR

2 a. Given a 60μC point charge located at the origin, find the total electric flux passing through

i) That portion of the sphere r = 26cm bounded by $0 < \theta < \frac{\pi}{2}$ and $0 < \phi < \frac{\pi}{2}$

ii) The closed surface defined by ρ = 26cm and z = ± 26cm. **(07 Marks)**

b. Derive an expression for electric field intensity at a distant point due to infinite line charge distribution. **(08 Marks)**

c. A uniform volume charge density of $80\mu C/m^3$ is present throughout the region 8mm < r < 10mm. Let $\rho_r = 0$ for 0 < r < 8mm.

i) Find the total charge inside the spherical surface r = 10mm

ii) Find D_r at r = 10mm

iii) If there is no charge for r > 10mm, find D_r at r = 20mm. **(05 Marks)**

Module-2

3 a. State and prove Gauss law. **(05 Marks)**

b. Determine the work done in carrying a 2μC charge from (2, 1, –1) to (8, 2, –1) in the field $\vec{E} = ya_x + xa_y$ along

i) the parabola $x = 2y^2$

ii) the hyperbola $x = \frac{8}{(7-3y)}$. **(08 Marks)**

c. Determine an expression for the volume charge density associated with each $\vec{D}$ field following :

i) $\vec{D} = \frac{4xy}{z}a_x + \frac{2x^2}{z}a_y + \frac{2x^2y}{z^2}a_z$

ii) $\vec{D} = z\sin\phi a_\rho + z\cos\phi a_\phi + \rho\sin\phi a_z$

iii) $\vec{D} = \sin\theta\sin\phi a_\gamma + \cos\theta\sin\phi a_\theta + \cos\phi a_\phi$. **(07 Marks)**

OR

4 a. Two uniform line charges, 8nC/m each, are located at x= 1, z = 2 and at x = –1, y = 2 in free space. If the potential at the origin is100V, find V at P(4, 1, 3). **(08 Marks)**

b. Within the cylinder $\rho = 2, 0 < z < 1$, the potential is given by $v = 100 + 50\rho + 150\rho \sin\phi$ V. Find $V, \vec{E}, \vec{D}$ and ρ_V at P(1, 60°, 0.5) in free space. **(08 Marks)**

c. Derive equation of continuity. **(04 Marks)**

Module-3

5 a. Derive Poisson's and Laplaces equation. **(05 Marks)**

b. A uniform volume charge has constant density $\rho_V = \rho_0$ C/m^3, and fills the region $r < a$, in which permittivity '$\in$' is assumed. A conducting spherical shell is located at $r = a$ and is held at ground potential. Find :

i) the potential everywhere

ii) the electric field intensity, $\vec{E}$ everywhere. **(09 Marks)**

c. Explain Biot-Savart's law. **(06 Marks)**

OR

6 a. State and prove Stoke's theorem. **(05 Marks)**

b. A solid conductor of circular cross-section with a radius of 5mm has a conductivity that varies with radius. The conductor is 20m long, and there is a potential difference of 0.1V DC between its two ends. Within conductor, $H = 10^5\rho^2 a_\phi$ A/m.

i) Find 'σ' conductivity as a function ρ charge density

ii) What is the resistance between the two ends? **(08 Marks)**

c. A straight conductor of length '2L' carrying a current 'I' coincides with z direction. Obtain an expression for vector magnetic potential at a point in a bisecting plane of the conductor. Also find magnetic flux density $\vec{B}$ at that point. **(07 Marks)**

Module-4

7 a. The point charge Q = 18nC has a velocity of 5×10^6m/s in the direction :

$a_V = 0.60a_x + 0.75a_y + 0.30a_z$

Calculate the magnitude of the force exerted on the charge by the field :

i) $\vec{B} = -3a_x + 4a_y + 6a_z$ mT

ii) $\vec{E} = -3a_x + 4a_y + 6a_z$ kV/m

iii) $\vec{B}$ and $\vec{E}$ acting together. **(07 Marks)**

b. Obtain an expression for the force between differential current elements. **(07 Marks)**

c. Write a note on magnetic boundary conditions. **(06 Marks)**

OR

8 a. Find the magnetic field intensity 'H' inside a magnetic material, given the following :

i) $M = 100$ A/m, $\mu = 1.5 \times 10^{-5}$ H/m

ii) $B = 200\mu T$, $\chi_m = 15$. **(06 Marks)**

b. Derive an expression for energy stored in the magnetic field. **(06 Marks)**

c. A current element $I_1 dl_1 = 10^{-4} a_z$ A.m is located at $P_1(2, 0, 0)$ another current element $I_2 dl_2 = 10^{-6}[a_x - 2a_y + 3a_z]$ A.m is located at $P_2(-2, 0, 0)$ and both are in free space :

i) Find force exerted on $I_2 dl_2$ by $I_1 dl_1$

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

Module-5

9 a. Define Faraday's law. Derive Maxwell's equation from Faraday's law in point form. **(07 Marks)**

b. Let $\mu = 3 \times 10^{-5}$H/m, $\in = 1.2 \times 10^{-10}$F/m, and $\sigma = 0$ everywhere. If $\vec{H} = 2\cos(10^{10} t - \beta x) a_z \text{A/m}$, use Maxwell's equations to obtain expressions for $\vec{D}$ and $\vec{E}$ **(06 Marks)**

c. Derive wave equations in free space for a uniform plane wave. **(07 Marks)**

OR

10 a. State and prove Poynting's theorem. **(08 Marks)**

b. Discuss wave propagation in good conductor. **(07 Marks)**

c. A certain lossless material has $\mu_r = 4$ and $\in_r = 9$. A 10MHz uniform plane wave is propagating in the α_y direction with $E_{x_0} = 400 \text{V/m}$ and $E_{y_0} = E_{z_0} = 0$ at P(0.6,0.6,0.6) at t = 60ns. Find 'β', λ, v_p and η. **(05 Marks)**

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