CBCS SCHEME

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15EC36

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
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. Define electric field intensity and electric flux density and derive the expression for D due to point charge. **(05 Marks)**

b. Identical point charges of 3μC are located at the four corners of the square of 5cm side, find the magnitude of force on any one charge. **(08 Marks)**

c. On the line described x = 4m, y = -2m there is uniform charge distribution of density ρ_l = 10nc/m. Find $\bar{E}$ at (4, 2, -1)m. **(03 Marks)**

OR

2 a. State and explain Coulomb's law of force between two point charges in vector form and mention the units of quantities in the force equation. **(08 Marks)**

b. Three point charges Q_1 = -1μc, Q_2 = -2μc and Q_3 = -3μc are placed at the corners of an equilateral triangle of side 1m, find the magnitude of the electric field intensity at the point bisecting the line joining Q_1 and Q_2. **(08 Marks)**

Module-2

3 a. In the region $r \le 2$, $\bar{D} = \frac{7r^2}{3}\hat{a}r$ and in the region $r > 2$, $\bar{D} = \frac{120}{r^2}\hat{a}r$ in spherical coordinate system calculate the charge density. **(08 Marks)**

b. Derive the expression for continuity of current. **(04 Marks)**

c. Derive Maxwell's first equation in electrostatic. **(04 Marks)**

OR

4 a. Obtain the boundary condition at the interface between a dielectric material and a conductor. **(08 Marks)**

b. State and explain Gauss law in point form. **(04 Marks)**

c. If the potential field $V = 3x^2 + 3y^2 + 2z^3$ volts, find: i) V ii) E iii) $\bar{P}$ at P(-4, 5, 4). **(04 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 = 5mm. If v = 0 at z = 0 and v = 100v at z = 5mm, 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. Obtain the expression for reluctance in a series of magnetic circuits. **(04 Marks)**

b. A point charge of Q = -1.2C has velocity, $\overline{V} = (5\hat{a}x + 2\hat{a}y - 3a\hat{z})m/s$. Find the magnitude of the force exerted on the charge if,

i) $\overline{E} = -18\hat{a}x + 5\hat{a}y - 10\hat{a}z$ v/m

ii) $\overline{B} = -4\hat{a}x + 4\hat{a}y + 3\hat{a}z$ T

iii) Both are present simultaneously. **(08 Marks)**

c. Two infinitely long straight conductors are located at x = 0, y = 0 and x = 0, y = 10m. Both carry current of 10A in positive $\hat{a}_z$ direction. Determine force experienced per meter between them. **(04 Marks)**

OR

8 a. State and explain Lorentz force equation. **(08 Marks)**

b. Find the magnetization in a magnetic material where,

i) $\mu = 1.8 \times 10^5$ (H/m) and M = 120 (A/M)

ii) $\mu_r = 22$, there are 8.3×10^{28} atoms/m^3 and each atom has a dipole moment of 4.5×10^{-27}(A/m^2) and

iii) B = 300μT and $\chi_m = 15$. **(08 Marks)**

Module-5

9 a. Starting from Maxwell's equation derive wave equation in E and H for a uniform plane wave travelling in free space. **(08 Marks)**

b. A homogeneous material has $\epsilon = 2 \times 10^9$ F/m and $\mu = 1.25 \times 10^{-6}$H/m and $\sigma = 0$. Electric field intensity is given as $\overline{E} = 400\cos(10^9 t - kz)\ \hat{a}n$ v/m, if all the fields vary sinusoidally find $\overline{D}$, $\overline{B}$ and $\overline{H}$. Also find k using Maxwell's equations. **(08 Marks)**

OR

10 a. List Maxwell's equation in point form and integral form. **(06 Marks)**

b. A 15GHZ plane wave travelling in a medium has an amplitude E_0 = 20v/m. Find phase velocity, propagation constant and impedance. Assume $\epsilon_r = 2$ and $\mu_r = 5$. **(06 Marks)**

c. 8 watts/m^2 is the pointing vector of a plane wave travelling in free space. What is the average energy density? **(04 Marks)**

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