CBCS SCHEME

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17EC36

Third Semester B.E. Degree Examination, June/July 2019
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 of force between two point charges in vector form. **(06 Marks)**

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

c. Define Electric Field Intensity. Derive the electric field intensity due to 'n' number of point charges. **(06 Marks)**

OR

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

b. Obtain the expression for an electric field intensity due to charged circular ring of radius 'r' placed in x-y plane, at a point (0, 0, z), having uniform line charge density of ρ_L (c/m). **(06 Marks)**

c. A uniform line charge $\rho_L = 25$ nc/m lies on the line $x = -3$m and $y = 4$m in free space. Find the electric field intensity at a point (2, 3, 15) **(06 Marks)**

Module-2

3 a. State and explain Gauss's law and prove Gauss's law as applied to point charge. **(06 Marks)**

b. Given that the field $\vec{D} = \frac{5\sin\theta\cos\phi}{r}\,\vec{a}_r$ (c/m^2). Find volume charge density. **(06 Marks)**

c. Given $\vec{D} = 5r\,\vec{a}_r$ (c/m^2), prove divergence theorem for a shell region enclosed by spherical surfaces at r = a and r = b (b > a) and centered at the origin. **(08 Marks)**

OR

4 a. Explain the concept of work and potential and obtain the expression for potential difference between two points due to an electric field produced by a point charge. **(06 Marks)**

b. Obtain the point form of continuity equation. **(06 Marks)**

c. Given the current density $\vec{J} = \frac{2}{r^2}\cos\theta\,\vec{a}_r + 20e^{-2r}\sin\theta\,\vec{a}_\theta - r\sin\theta\cos\phi\,\vec{a}_\phi$ (A/m^2)

i) Find $\vec{J}$ at r = 3m, $\theta = 0°$, $\phi = \pi$.

ii) Find the total current passing through spherical surface r = 3m, $0 < \theta < 20°$, $0 < \phi < 2\pi$. **(08 Marks)**

Module-3

5 a. From point form of Gauss's law, derive Poisson's and Laplace's equation. **(05 Marks)**

b. State and prove uniqueness theorem. **(08 Marks)**

c. Applying Laplace's equation, obtain the expression for capacitance of a parallel plate capacitor. The distance between two plates are 'd' and the area of plate is 'A'. **(07 Marks)**

OR

6 a. Using Biot - Savart law obtain the expression for magnetic field intensity at a point due to infinitely long straight conductor. **(08 Marks)**

b. Given the magnetic field $\vec{H} = 2r^2(z+1)\sin\phi\,\vec{a\phi}$. Verify stokes theorem for the portion of a cylindrical surface defined by r = 2, $\frac{\pi}{4} \le \phi \le \frac{\pi}{2}$, $1 \le z \le 1.5$ and for its perimeter. Given vector magnetic potential. **(08 Marks)**

c. $\vec{A} = x^2\,\vec{a}_x + 2yz\,\vec{a}_y - x^2\,\vec{a}_z$. Find the magnetic flux density. **(04 Marks)**

Module-4

7 a. Derive the expression for the force acting on a differential current element placed in a magnetic field. **(06 Marks)**

b. A point charge Q = –1.2 (C) has velocity $\vec{V} = 5\vec{a}_x + 2\vec{a}_y - 3\vec{a}_z$ m/s. Find the magnitude of the force exerted on the charge if

i) $\vec{E} = -18\vec{a}_x + 5\vec{a}_y - 10\vec{a}_z$ (V/m)

ii) $\vec{B} = -4\vec{a}_x + 4\vec{a}_y + 3\vec{a}_z$ (T) **(06 Marks)**

c. A current element $I_1dL_1 = 10^{-4}\,\vec{a}_z$ (A.m) is located at $P_1(2, 0, 0)$ and another current element $I_2\,dL_2 = 10^{-6}\,(\vec{a}_x - 2\vec{a}_y + 3\vec{a}_z)$ (A.m) is located at $P_2(-2, 0, 0)$. Find the force exerted on I_1dL_1 by I_2dL_2. **(08 Marks)**

OR

8 a. Discuss the magnetic boundary conditions as applicable to $\vec{B}$ and $\vec{H}$ at the interface between two different magnetic materials. **(10 Marks)**

b. Write short notes on :

i) Energy Density in magnetic field ii) Forces on magnetic materials. **(10 Marks)**

Module-5

9 a. List Maxwell's equations in integral form and derive the point form of Maxwell's equation for time varying fields. **(12 Marks)**

b. Show that in a capacitor the conduction current density is equal to displacement current density for applied voltage $V(t) = V_o \cos \omega t$. **(08 Marks)**

OR

10 a. What is Uniform plane wave? Derive the expression of uniform plane wave travelling in free space. **(10 Marks)**

b. State and prove Poynting theorem. Also show that average power

$P_{avg} = \frac{1}{2}\,\frac{E_m^2}{\eta}\,(W/m^2)$. **(10 Marks)**

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