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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 $3\mu\text{C}$ 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 $\rho_L = 25 \text{ nC/m}$ lies on the line $x = -3\text{m}$ and $y = 4\text{m}$ 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/m²). Find volume charge density. (06 Marks)
- c. Given $\vec{D} = 5r \vec{a}_r$ (c/m²), 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/m²)
 - i) Find \vec{J} at $r = 3\text{m}$, $\theta = 0^\circ$, $\phi = \pi$.
 - ii) Find the total current passing through spherical surface $r = 3\text{m}$, $0 < \theta < 20^\circ$, $0 < \phi < 2\pi$. (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)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
 2. Any revealing of identification, appeal to evaluator and /or equations written e.g. 42+8 = 50, will be treated as malpractice.



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 $r = 2$, $\frac{\pi}{4} \leq \phi \leq \frac{\pi}{2}$, $1 \leq z \leq 1.5$ 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 $I_1 dL_1 = 10^{-4}\vec{a}_z$ (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 $I_1 dL_1$ by $I_2 dL_2$. (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 $V(t) = V_0 \cos \omega t$. (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

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