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15EC36

Third Semester B.E. Degree Examination, June/July 2018
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 flux density and also establish the relationship between them. **(04 Marks)**

b. State and explain Coulomb's law of force between two print charges. **(06 Marks)**

c. Two uniform line charges of densities 4 nc/m and 6nc/m lying x = 0 plane at y = 5m and y = -6m respectively. Find electric field intensity at P(4, 0, 5)m. **(06 Marks)**

OR

2 a. Derive an expression for electric field intensity due to infinite line charge. **(08 Marks)**

b. A volume charge density $\rho_v = \frac{5k}{r}$, where $r \neq 0$, k = constant exists within a sphere of radius $\frac{a}{2}$. Determine the magnitude of point charge placed at origin which will produce the same electric field at $r = \frac{a}{2}$. **(08 Marks)**

Module-2

3 a. Derive the Maxwell's first equation in electrostatics. **(04 Marks)**

b. Derive the expression for continuity of current. **(06 Marks)**

c. Find the total charge in a volume defined by six planes for which $1 \leq x \leq 2$; $2 \leq y \leq 3$; $3 \leq z \leq 4$. If $\vec{D} = \left[4x\hat{a}_x + 3y^2\,\hat{a}_y + 2z^3\,\hat{a}_z\right]$ c/m^2. **(06 Marks)**

OR

4 a. Briefly explain Gauss's divergence theorem. **(06 Marks)**

b. Obtain an expression for the energy expanded in moving a point charge in an electric field. **(06 Marks)**

c. Let $V = \frac{\cos 2\phi}{r}$ in free space in cylindrical system. Find $\vec{E}$ at B(2, 30°, 1). **(04 Marks)**

Module-3

5 a. With the usual notations, deduce the Poisson's and Laplace's equation from the Maxwell's first equation. **(06 Marks)**

b. Determine whether or not the following vector represents a possible electric field. $\vec{E} = 5\cos z\,\hat{a}_z$ V/m. **(04 Marks)**

c. Prove that the line integral of magnetic field intensity $\vec{H}$ around a closed path is exactly equal to current 'I' enclosed by that path. **(06 Marks)**

OR

6 a. Solve Laplace's equation to determine the capacitance of a coaxial cable when the inner radius is 'a' and outer radius is 'b' respectively. **(08 Marks)**

b. State and explain 'stokes theorem'. **(04 Marks)**

c. Given the vector magnetic potential $\vec{A} = x^3 \hat{a}_x + 2yz\,\hat{a}_y + (-x^2)\hat{a}_z$. Find magnetic flux density. **(04 Marks)**

Module-4

7 a. Derive Lorentz force equation and mention the application of solution. **(05 Marks)**

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

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

ii) $\vec{B} = -4\,\hat{a}_x + 4\,\hat{a}_y + 3\,\hat{a}_z$ T

iii) Both are present simultaneously. **(06 Marks)**

c. Briefly explain force between differential current elements. **(05 Marks)**

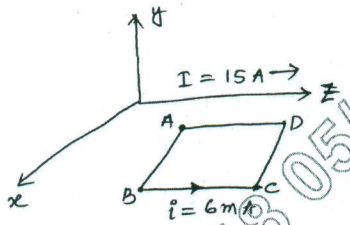
OR

8 a. Discuss the magnetic boundary condition at the interface between two different magnetic materials. **(05 Marks)**

b. Briefly explain potential energy and forces on magnetic materials. **(05 Marks)**

c. A rectangular loop of wire in free space joins A(1, 0, 1), B (3, 0, 1) to C(3, 0, 4) to D (1, 0, 4) to A. The wire carries a current of 6mA flowing in $\hat{a}_z$ direction from B to C. A filamentary current of 15A flows along the entire z-axis in the $\hat{a}_z$ direction as shown in Fig.Q.8(c). Find: i) Force on side BC ii) Force on side AB iii) Total force on loop. **(06 Marks)**

Fig.Q.8(c)



Module-5

9 a. State and explain Faraday's law in point and integral form. **(06 Marks)**

b. Derive Ampere's circuit law in point form and integral form suitable for Time-varying fields. **(07 Marks)**

c. Find the angular frequency at which the conduction current and displacement current are equal in medium with $\sigma = 5.6 \times 10^{-5}$ S/m and $\epsilon_r = 40$. **(03 Marks)**

OR

10 a. State and prove Poynting theorem. **(06 Marks)**

b. Briefly explain skin depth and skin effect. **(05 Marks)**

c. A 300MHz uniform plane wave propagation through fresh water for which $\sigma = 0$, $\mu_r = 1$ and $\epsilon_r = 78$. Calculate:

i) Attenuation constant

ii) Phase constant

iii) Wave length

iv) Intrinsic impedance. **(05 Marks)**

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