CBCS Scheme

USN | | | | | | | | | | 15EC36

Third Semester B.E. Degree Examination, Dec.2017/Jan.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. State and explain Coulomb's law in vector form. **(05 Marks)**

b. Find the electric field $\bar{E}$ at origin, if the following charge distributions are present in free space:
   i) Point charge 12 nc at P(2, 0, 6).
   ii) Uniform line charge of linear charge density 3 nc/m at x = 2, y = 3.
   iii) Uniform surface charge of density $P_s = 0.2$ nc/m^2 at x = 2. **(06 Marks)**

c. Define volume charge density. Also find the total charge within each of the indicated volumes.
   i) $0 \le \rho \le 0.1,\ 0 \le \phi \le \pi,\ 2 \le z \le 4;\ \rho_v = \rho^2 z^2 \sin(0.6\phi)$
   ii) Universe : $\rho_v = \dfrac{e^{-2r}}{r^2}$ **(05 Marks)**

OR

2 a. Define Electric flux and flux density. **(04 Marks)**

b. Given a 60 μC point charge located at the origin, find the total electric flux passing through:
   i) That portion of the sphere r = 26 cm bounded by $0 < \theta < \dfrac{\pi}{2}$ and $0 < \phi < \dfrac{\pi}{2}$.
   ii) The closed surface defined by ρ = 26 cm and z = ±26 cm.
   iii) The plane z = 26 cm. **(07 Marks)**

c. Derive the expression for $\bar{E}$ due to infinite line charge of charge density ρ_L (c/m). **(05 Marks)**

Module-2

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

b. State and prove divergence theorem. **(05 Marks)**

c. In each of the following parts, find value for div $\bar{D}$ at the point specified:
   i) $\bar{D} = (2xyz - y^2)\bar{a}_x + (x^2z - 2xy)\bar{a}y + x^2y\bar{a}_z$ c/m^2 at P_A(2, 3, -1).
   ii) $\bar{D} = 2\rho z^2 \sin^2\phi\bar{a}_\rho + \rho z^2 \sin 2\phi\bar{a}_\phi + 2\rho^2 z \sin^2\phi\bar{a}_z$ c/m^2 at P_B(ρ = 2, φ = 110°, z = -1). **(06 Marks)**

OR

4 a. Define potential difference and absolute potential. **(04 Marks)**

b. A point charge of 6 nc is located at origin in free space, find potential of point p, if p is located at (0.2, -0.4, 0.4) and
   i) V = 0 at infinity
   ii) V = 0 at (1, 0, 0)
   iii) V = 20 V at (-0.5, 1, -1) **(06 Marks)**

c. Derive point form of continuity equation for current. **(06 Marks)**

Module-3

5 a. Derive the expression for Poisson's and Laplace's equation. **(05 Marks)**

b. Two plates of parallel plate capacitors are separated by distance 'd' and maintained at potential zero and V_0 respectively. Assuming negligible fringing effect, determine potential at any point between the plates. **(06 Marks)**

c. State and prove uniqueness theorem. **(05 Marks)**

OR

6 a. State and explain Biot-Savart law. **(06 Marks)**

b. Find the magnetic flux density at the centre '0' of a square of sides equal to 5m and carrying 10 amperes of current. **(06 Marks)**

c. At a point p(x, y, z), the components of vector magnetic potential $\overline{A}$ are given as $A_x = 4x + 3y + 2z$, $A_y = 5x + 6y + 3z$ and $A_z = 2x + 3y + 5z$. Determine $\overline{B}$ at point P. **(04 Marks)**

Module-4

7 a. Derive Lorentz force equation. **(05 Marks)**

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

c. A conductor 4m long lies along the y-axis with a current of 10 amps in the $\overline{a}_y$ direction. Find the force on the conductor if the field is $\overline{B} = 0.005\,\overline{a}_x$ Telsa. **(05 Marks)**

OR

8 a. Define: i) Magnetization, ii) Permeability. **(04 Marks)**

b. Find the magnetization in a magnetic material where
   i) $\mu = 1.8 \times 10^5$ (H/m) and 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 = 300 μT and $\chi_m = 15$ **(06 Marks)**

c. Discuss the boundary conditions at the interface between two media of different permeabilities. **(06 Marks)**

Module-5

9 a. State and explain Faraday's law of electromagnetic induction. **(04 Marks)**

b. Find the frequency at which conduction current density and displacement current are equal in a medium with $\sigma = 2 \times 10^{-4}$ ℧/m and $\varepsilon_r = 81$. **(06 Marks)**

c. List Maxwell's equations in point form and integral form. **(06 Marks)**

OR

10 a. Obtain solution of the wave equation for a uniform plane wave in free space. **(06 Marks)**

b. State and prove Poynting theorem. **(06 Marks)**

c. The depth of penetration in a certain conducting medium is 0.1 m and the frequency of the electromagnetic wave is 1.0 MHz. Find the conductivity of the conducting medium. **(04 Marks)**

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