CBCS SCHEME

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

Third Semester B.E. Degree Examination, Aug./Sept.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, $\vec{E}$. Find $\vec{E}$ at $(2, \frac{\pi}{2}, \frac{\pi}{6})$ due to a point charge located at origin. Let Q = 40nC. **(04 Marks)**

b. Point charges of 120nC are located at A (0, 0, 1) and B(0, 0, -1) in free space. Find $\vec{E}$ at P(x, 0, 0). Also find the maximum value of $\vec{E}$. **(06 Marks)**

c. Uniform line charges of 120 nC/m each lie along the entire extent of the three co-ordinate axes. Assuming free space conditions, find $\vec{E}$ at P(-3, 2, -1)m. **(06 Marks)**

OR

2 a. Derive an expression for electric field intensity at a point in cylindrical coordinate system due to an infinite line charge distribution on Z - axis. **(06 Marks)**

b. A point charge $Q_1 = 10\ \mu C$ is located at $P_1(1, 2, 3)$m in free space while $Q_2 = -5\mu C$ is at $P_2(1, 2, 10)$m. i) Find vector force exerted on Q_2 by Q_1 ii) Also, find the co-ordinates of P_3 at which a point charge Q_3 experiences no force. **(07 Marks)**

c. Find the total electric flux crossing an infinite plane at y = 0 due to the following charge distributions :
- a point charge, 30nC located at (1, 2, 3).
- Two line charge distributions of 10nC/m each located in x = 0 plane at y = ± 2m extending over a length of 4m. **(03 Marks)**

Module-2

3 a. Define 'Divergence of a Vector' and 'Gradient of a Scalar'. **(04 Marks)**

b. Derive the point form of Gauss's law. **(06 Marks)**

c. Give the flux density, $\vec{D} = \frac{5\sin\theta\cos\phi}{r}\hat{a}_r$, c/m^2. Find
- Volume charge density
- Total charge contained in the region, r < 2m.
- Total electric flux leaving the surface, r = 2m. **(06 Marks)**

OR

4 a. The value of $\vec{E}$ at $P(\rho = 2, \phi = 40^0, Z = 3)$ is given by $\vec{E} = 100\,\hat{a}_\rho - 200\,\hat{a}_\phi + 300\,\hat{a}_z$, V/m. Determine the incremental work required to move a 20μC charge a distance of 6μm in the direction of : i) $\hat{a}_\rho$ ii) $\vec{E}$ iii) $\vec{G} = \hat{a}_\rho + 3\hat{a}_\phi - 2\hat{a}_z$. **(06 Marks)**

b. State and explain continuity equation of current. **(05 Marks)**

c. Given the potential field $V = 2x^2y - 80$, and a point, P(2, 3, -4) in free space, find at 'P'.
i) V ii) $\vec{E}$ iii) $\frac{dV}{dN}$ iv) $\hat{a}_N$.
Where $\hat{a}_N$ is the unit vector normal to equipotential surface? **(05 Marks)**

Module-3

5 a. Conducting plates at Z = 2cm and Z = 8cm are held at potentials of -3V and 9V respectively. The region between the plates is filled with a perfect dielectric of $\epsilon = 5\epsilon_0$. Find V, $\vec{E}$ and $\vec{D}$ in the region between the plates. **(06 Marks)**

b. Let $V = \frac{\cos 2\phi}{\rho}$ volts in free space. Find volume charge density at P(5, 60^0, 1) using Poisson's equation. **(05 Marks)**

c. State the following : i) Uniqueness theorem ii) Ampere's law iii) Stoke's theorem. **(05 Marks)**

OR

6 a. Explain Scalar and Vector magnetic potentials. **(05 Marks)**

b. Verify Stoke's theorem for $\vec{H} = 2r \cos\theta \; \hat{a}_r + r \; \hat{a}_\phi$ for the path defined by $0 \le r \le 1$ and $0 \le \theta \le 90^0$. **(06 Marks)**

c. The magnetic field intensity is given by $\vec{H} = 0.1 \; y^3 \; \hat{a}_x + 0.4 \; x \; \hat{a}_z$, A/m. Determine the current flow through the path $P_1(5, 4, 1)$ to $P_2(5, 6, 1)$ to $P_3(0, 6, 1)$ to (0, 4, 1). Also find current density , $\vec{J}$. **(05 Marks)**

Module-4

7 a. Obtain an expression for magnetic force between differential current elements. **(05 Marks)**

b. A point charge , Q = 18nC has a velocity of 5×10^6 m/s in the direction $\hat{a} = 0.6 \; \hat{a}_x + 0.75 \, \hat{a}_y + 0.3 \, \hat{a}_z$. Calculate the magnitude of the force exerted on the charge by the field $\vec{B} = -3\,\hat{a}_x + 4\,\hat{a}_y + 6\,\hat{a}_z$, mT. **(05 Marks)**

c. Three infinitely long parallel filaments each carry 50A in the $\hat{a}_z$ direction. If the filament lie in the plane, x = 0 with a 2cm spacing between wires, find the vector fore per meter on each filament. **(06 Marks)**

OR

8 a. Obtain the boundary conditions at the interface between two magnetic materials. **(05 Marks)**

b. Find Magnetization in magnetic material where
i) $\mu = 1.8 \times 10^{-5}$ H/m and H = 120 A/m ii) B = 300μT and $X_m = 15$. **(05 Marks)**

c. Explain briefly the following as applicable to magnetic materials :
i) Magnetization ii) Permeability iii) Potential energy. **(06 Marks)**

Module-5

9 a. Write Maxwell's equations in integral form and word statement form for free space. **(06 Marks)**

b. In a certain dielectric medium , $\epsilon_r = 5$, $\sigma = 0$ and displacement current density $\vec{J}_d = 20 \cos(1.5 \times 10^8 \, t - bx) \; \hat{a}_y$, μA/m^2. Determine electric flux density and electric field intensity. **(06 Marks)**

c. A radial magnetic field $\vec{H} = \frac{2.239 \times 10^6}{r} \cos\phi \; \hat{a}_r$, a/m exists in free space. Find the magnetic flux, ϕ crossing the surface defined by $-\frac{\pi}{4} \le \phi \le \frac{\pi}{4}$, $0 \le z \le 1$, m. **(04 Marks)**

OR

10 a. Discuss the wave propagation of a uniform plane wave in a good conducting medium. **(06 Marks)**

b. Derive the relation between $\vec{E}$ and $\vec{H}$ for a perfect dielectric medium. **(05 Marks)**

c. Determine the skin depth for copper with conductivity of 58×10^6 , S/m at a frequency , 10 MHz. Also find α , β and V_p. **(05 Marks)**

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