CBCS SCHEME

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15EC36

Third Semester B.E. Degree Examination, July/August 2022
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 prove Coulomb's law. **(05 Marks)**

b. Three equal charges of 1 μC each are located at the three corners of a square of 10 cm side. Find the electric field intensity at the forth vacant corner of the square. **(06 Marks)**

c. A charge $Q_1 = -20\mu C$ is located at P(−6,4,6) and a charge $Q_2 = 50\mu C$ is located at R(5, 8, −2) in a free space. Find the force exerted on Q_2 by Q_1 in vector form. The distance given in meter. **(05 Marks)**

OR

2 a. Derive the expression of electric field intensity for infite line charge. **(08 Marks)**

b. Find the electric field $\vec{E}$ at the 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 3 nC at x = 2, y = 3. **(08 Marks)**

Module-2

3 a. State and prove the Gauss's law. **(05 Marks)**

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

c. If $\vec{D} = xy^2z^2\hat{a}_x + x^2yz^2\hat{a}_y + x^2y^2z\,\hat{a}_z\ C/m^2$.

Find :

(i) An expression for ρ_v

(ii) The total charge within the cube defined by $0 \le x \le 2,\ 0 \le y \le 2,\ 0 \le z \le 2$. **(06 Marks)**

OR

4 a. Derive the expression for work done interms of line integral. **(06 Marks)**

b. Given $V = \frac{\cos 2\phi}{r}$ in the free space, in cylindrical system:

(i) Find $\vec{E}$ at B(2, 30°, 1).

(ii) Find the volume charge density at point A(0.5, 60°, 1). **(10 Marks)**

Module-3

5 a. Derive the expression for Poisson's and Laplace's equation. **(04 Marks)**

b. Determine whether or not the following potential field satisfy the Laplace's equation:

(i) $V = x^2 - y^2 + z^2$

(ii) $V = r\cos\phi + z$ **(04 Marks)**

c. Use Laplace's equation to find the capacitance per unit length of a co-axial cable of inner radius 'a' in and outer radius 'b' m . Assume $V = V_0$ at r = a, V = 0 at r = b. **(08 Marks)**

OR

6 a. State and explain Biot-Savart law. **(05 Marks)**

b. State and prove the Stoke's theorem. **(06 Marks)**

c. Given $\vec{A} = (\sin 2\phi)\hat{a}_\phi$ in cylindrical coordinates. Find curl of $\vec{A}$ at $\left(2, \frac{\pi}{4}, 0\right)$. **(05 Marks)**

Module-4

7 a. Derive the expression for the force on a differential current element. **(06 Marks)**

b. A point charge of 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 the 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. **(10 Marks)**

OR

8 a. Write short notes on Magnetization and Permeability. **(06 Marks)**

b. Derive the boundary condition for tangential component in magnetic field. **(05 Marks)**

c. A coil of 500 turns is wound on a closed iron ring of mean radius 10 cm and cross section area of 3 cm^2. Find the self inductance of the winding if the relative permeability of iron is 800. **(05 Marks)**

Module-5

9 a. Write the Maxwell equations in point form and integral form. **(06 Marks)**

b. Given $\vec{E} = E_m \sin(\omega t - \beta z)\hat{a}_y$ in free space. Find $\vec{D}$, $\vec{B}$ and $\vec{H}$. **(06 Marks)**

c. Prove that $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$. **(04 Marks)**

OR

10 a. Derive the general expression for uniform plane in free space. **(05 Marks)**

b. State and prove Poynting theorem. **(07 Marks)**

c. Calculate the attenuation constant and phase constant for a uniform plane wave with frequency of 10 GHz in polythelene for which $\mu = \mu_o$, $\varepsilon_r = 2.3$ and $\sigma = 256 \times 10^{-4}$ ʊ/m. **(04 Marks)**

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