USN

17EC36

Third Semester B.E. Degree Examination, Feb./Mar.2022
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 in vector form. **(07 Marks)**

b. Let a point charge of $Q_1 = 20\ \eta C$ be located at $A(3,-1,5)$ and a charge of $Q_2 = 40\ \eta C$ be located at $B(-2,3,0)$. Find force $\overline{F}$ at C(1, 2, 3) having charge of Q_3 of 10 μC in free space. **(08 Marks)**

c. Define electric field intensity $\overline{E}$ and explain the method of obtaining $\overline{E}$ at a point in Cartesian co-ordinate system due to point charge Q. **(05 Marks)**

OR

2 a. Obtain the expression for electric field $\overline{E}$ due to infinite line change with charge density of ρ_L C/m, at point P on y-axis at a distance 'r' from the origin. The line is placed along z-axis. **(08 Marks)**

b. Define electric flux density $\overline{D}$. Obtain the expression for $\overline{D}$ due to point charge and infinite line charge. **(06 Marks)**

c. Find $\overline{D}$ at P(6, 8, -10) m due to uniform infinite line charge with charge density (ρ_L) of 40 μC/m on z-axis. **(06 Marks)**

Module-2

3 a. State and prove Gauss's law. **(08 Marks)**

b. Find div $\overline{D}$ for the following field,

(i) $\overline{D} = (2xy - y^2)\overline{a}_x + (x^2z - 2xy)\overline{a}_y + x^2y\,\overline{a}_z$ C/m^2 at $P_1(2,3,-1)$.

(ii) $\overline{D} = 2rz^2\sin^2\phi\,\overline{a}_r + rz^2\sin 2\phi\,\overline{a}_\phi + 2r^2z\sin^2\phi\,\overline{a}_z$ C/m^2 at $P_2(r = 2,\ \phi = 110^\circ,\ z = -1)$ **(06 Marks)**

c. State and Prove divergence theorem. **(06 Marks)**

OR

4 a. Obtain the expression for potential difference by bringing a unit positive charge from Point B to Point A. The point B is at r_B distance and point A is at r_A from the origin. **(06 Marks)**

b. Show that the energy required to assemble 'n' number of point charges in an empty space is, $W_E = \frac{1}{2}\sum_{m=1}^{n} Q_m V_m$. **(08 Marks)**

c. Find the workdone in moving +2C charge from B(2, 0, 0) m to A(0, 2, 0) m along the straight line joining the two points. Assume that the electric field $\overline{E}$ is $12x\,\overline{a}_x - 4y\overline{a}_y$ V/m. **(06 Marks)**

Module-3

5 a. Starting from Gauss's law in point form, deduce Poisson's and Laplace's equations. **(06 Marks)**

b. Two plates of parallel plate capacitor or are separated by the distance of 'd' m and maintained at zero and V_0 voltages respectively. Determine capacitance between these two plates. **(08 Marks)**

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

OR

6 a. Obtain the expression for $\overline{H}$ in all the regions if a cylindrical conductor carries a direct current I and its radius is 'R' m. Plot the variation of $\overline{H}$ against the distance r from the centre of the conductor. **(08 Marks)**

b. Given the general vector $\overline{A} = \sin 2\phi \overline{a}_\phi$ in cylindrical co-ordinate system. Find curl of $\overline{A}$ at $\left(2, \frac{\pi}{4}, 0\right)$. **(06 Marks)**

c. Explain the concept of scalar and vector magnetic potentials. **(06 Marks)**

Module-4

7 a. Derive Lorentz force equation. **(06 Marks)**

b. Obtain the expression for magnetic force between two current elements and hence for current loops. **(08 Marks)**

c. A current element of 2 m in length lies along y axis centred at origin. The current is 5A in $\overline{a}_y$ direction. If it experience a force $1.5\frac{(\overline{a}_x + \overline{a}_z)}{\sqrt{2}}$N due to uniform field $\overline{B}$. Determine $\overline{B}$. **(06 Marks)**

OR

8 a. In certain region, the magnetic flux density of magnetic material with $X_m = 6$ is given by $\overline{B} = 0.005y^2\overline{a}_x T$. At y = 0.4 m, find the magnitude of $\overline{J}$. **(06 Marks)**

b. Derive the expression for the energy density in the magnetostatic fields. **(08 Marks)**

c. Tabulate the similarities of the electric and magnetic circuits. **(06 Marks)**

Module-5

9 a. A conductor of 1 cm in length is parallel to z-axis and rotates at radius of 25 cm at 1200 rpm. Find induced voltage if the radial field is given by, $\overline{B} = 0.5\overline{a}_r T$. **(06 Marks)**

b. Derive Maxwell's equation in point form from Ampere's circuit law and Gauss's law for static field. **(08 Marks)**

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

OR

10 a. Derive the General Wave equation starting from Maxwell's equations. **(08 Marks)**

b. A 300 MHz uniform plane wave propagates through fresh water for which $\sigma = 0$, $\mu_r = 1$ and $\epsilon_r = 78$. Calculate attenuation constant, phase constant, wavelength and intrinsic impedance. **(06 Marks)**

c. State and prove pointing theorem. **(06 Marks)**

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