CBCS SCHEME

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17EE45

Fourth Semester B.E. Degree Examination, Jan./Feb. 2021
Electromagnetic Field Theory

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Given three points P(2, –3, 1), Q(– 4, –2, 6) and R(1,5, –3), find (i) Vector from P to R (ii) Unit vector of the vector from P to R (iii) Distance from P to R **(06 Marks)**

b. Transform the vector $\overline{A} = 2\hat{a}_x - 3\hat{a}_y - 1\hat{a}_z$ to cylindrical coordinates at point P(2, 3, 5)? **(08 Marks)**

c. State and explain Coulomb's law in vector form. **(06 Marks)**

OR

2 a. State and prove Gauss divergence theorem. **(06 Marks)**

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

(i) An expression for ρ_v

(ii) Total charge within the cube defined by $0 \le x \le 2$, $0 \le y \le 2$, $0 \le z \le 2$. **(08 Marks)**

c. An infinite line charge with charge density 20 nc/m is kept along x = 2m and y = – 4m. Find the electric field intensity at a point (–2, –1, 4). **(06 Marks)**

Module-2

3 a. Prove that electric field intensity is expressed as negative gradient of Scalar Potential? **(06 Marks)**

b. Given potential field V = $2x^2y - 5z$ volts and a point P(–4, 3, 6). Find (i) Numerical values of V and E (ii) Direction of E (iii) $\overline{D}$ (iv) Volume charge density 'ρ_v'. **(08 Marks)**

c. Determine capacitance of parallel plate capacitor consisting of two plates 30cm × 30cm surface area, separated by 5mm in air. What is the energy stored if the capacitor is charged to 500V? **(06 Marks)**

OR

4 a. With usual notations derive the expression for energy required to assemble 'n' point charges in space. **(06 Marks)**

b. Derive the boundary condition for the interface between conductor and free space. **(08 Marks)**
A spherical condenser has a capacity of 54 pF. It consists of two concentric spheres differing in radii by 4 cm and having air as dielectric. Find their radii. **(06 Marks)**

Module-3

5 a. Derive Poisson's and Laplace equations? Write Laplace equations in all 3 coordinate system. **(06 Marks)**

b. State and explain uniqueness theorem. **(08 Marks)**

c. If $\overline{H} = 20\rho^2\hat{a}_\phi$ A/m, determine the current density $\overline{J}$ and the total current crossing a surface $\rho = 1m$; $0 \le \phi \le 2\pi$ and $2 = 0$ in cylindrical coordinate system? **(06 Marks)**

OR

6 a. State and explain (i) Biot – Savart's law (ii) Ampere's circuital law. **(06 Marks)**

b. Let $V = \frac{\cos 2\phi}{r}$ in free space, using Poisson's equations

Find (i) the volume charge density 'ρ_v' at a point A(0.5, 60°, 1) (ii) $\overline{E}$ at B(2, 30°, 1)? **(08 Marks)**

c. Explain scalar magnetic potential and vector magnetic potential? **(06 Marks)**

Module-4

7 a. Derive Lorentz's force equation with usual notations. **(06 Marks)**

b. Derive the boundary conditions at the interface between two magnetic materials of different permeabilities? **(08 Marks)**

c. Calculate the inductance of an air cored solenoid of 400 turns having 10 cm diameter and 50cm length. **(06 Marks)**

OR

8 a. Derive an expression for force on a differential current element? **(06 Marks)**

b. A current element $I_1\overline{dL_1} = 10^{-5}\hat{a}_z$ amp-m is located at $P_1(1, 0, 0)$, while second element $I_2\overline{dL_2} = 10^{-5}(0.6\hat{a}_x - 2\hat{a}_y + 3\hat{a}_z)$ amp-m is at $P_2(-1, 0, 0)$ both are in free space. Find vector force exerted on $I_2\overline{dL_2}$ by $I^1\overline{dL_1}$? **(08 Marks)**

c. A point charge $Q = -50$ nC is moving in a magnetic field of density $\overline{B} = 2\hat{a}_x - 3\hat{a}_y + 5\hat{a}_z$ mTelsa with a velocity of 6×10^6 m/s. Calculate the force in the direction specified by the unit vector $-0.48\hat{a}_x - 0.6\hat{a}_y + 0.64\hat{a}_z$ **(06 Marks)**

Module-5

9 a. List the Maxwell's equations for time varying fields in point form and integral form. **(06 Marks)**

b. Derive the Maxwell's first equation in point form for time varying field from Faraday's Law. **(06 Marks)**

c. The electric field of uniform plane wave is given by $\overline{E} = 40\sin(30\pi\times10^6 t - 2\pi z)\hat{a}_x + 40\cos(30\pi\times10^6 t - 2\pi z)\hat{a}_y$ V/m.

Find (i) Frequency of operation (ii) Wavelength (iii) Direction of propagation of wave (iv) Associated magnetic field $\overline{H}$. **(08 Marks)**

OR

10 a. State and explain Poynting theorem. **(08 Marks)**

b. A short vertical antenna erected on the surface of perfectly conducting earth produces effective field strength $E_{eff} = 100 \sin\theta$m V/m at points at a distance of 1 mile from the antenna. Compute the Poynting vector and total power radiated? **(08 Marks)**

c. Write a short note on Skin depth. **(04 Marks)**

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