

CBCS SCHEME

17EE45

USN

Date.....

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 $\vec{A} = 2\hat{a}_x - 3\hat{a}_y - \hat{a}_z$ 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 $\vec{D} = xyz^2\hat{a}_x + x^2yz^2\hat{a}_y + x^2y^2z\hat{a}_z$ c/m². Find
(i) An expression for ρ_v
(ii) Total charge within the cube defined by $0 \leq x \leq 2$, $0 \leq y \leq 2$, $0 \leq z \leq 2$. (08 Marks)
- c. An infinite line charge with charge density 20 nC/m is kept along $x = 2$ m and $y = -4$ m. 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) \vec{D} (iv) Volume charge density ' ρ_v '. (08 Marks)
- c. Determine capacitance of parallel plate capacitor consisting of two plates 30cm \times 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 $\vec{H} = 20\rho^2\hat{a}_\phi$ A/m, determine the current density \vec{J} and the total current crossing a surface $\rho = 1$ m; $0 \leq \phi \leq 2\pi$ and $z = 0$ in cylindrical coordinate system? (06 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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) \vec{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 $I_1 d\vec{L}_1 = 10^{-5} \hat{a}_z$ amp-m is located at $P_1(1, 0, 0)$, while second element $I_2 d\vec{L}_2 = 10^{-5} (0.6\hat{a}_x - 2\hat{a}_y + 3\hat{a}_z)$ amp-m is at $P_2(-1, 0, 0)$ both are in free space. Find vector force exerted on $I_2 d\vec{L}_2$ by $I_1 d\vec{L}_1$? (08 Marks)
- c. A point charge $Q = -50$ nC is moving in a magnetic field of density $\vec{B} = 2\hat{a}_x - 3\hat{a}_y + 5\hat{a}_z$ 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 $\vec{E} = 40 \sin(30\pi \times 10^6 t - 2\pi z) \hat{a}_x + 40 \cos(30\pi \times 10^6 t - 2\pi z) \hat{a}_y$ V/m.
Find (i) Frequency of operation (ii) Wavelength (iii) Direction of propagation of wave (iv) Associated magnetic field \vec{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 $E_{\text{eff}} = 100 \sin \theta$ mV/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)
