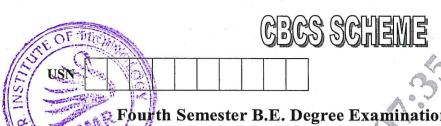
BANGAL Time: 3 hrs.



17EE45

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

Max. Marks: 100

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

Module-1

- 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
 - b. Transform the vector $A = 2\hat{a}_x 3\hat{a}_y 1\hat{a}_z$ to cylindrical coordinates at point P(2, 3, 5)?
 - State and explain Coulomb's law in vector form.

(08 Marks) (06 Marks)

State and prove Gauss divergence theorem.

(06 Marks)

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)
- 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

a. Prove that electric field intensity is expressed as negative gradient of Scalar Potential?

- 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} '.
- 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)

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

- 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 $\rho = 1 \text{m}$; $0 \le \phi \le 2\pi$ 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 $I_2 \overline{dL}_2 = 10^{-5} \left(0.6 \hat{a}_x 2 \hat{a}_y + 3 \hat{a}_z\right)$ 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

 $\overline{E} = 40 \sin(30\pi \times 10^6 t - 2\pi z) \hat{a}_x + 40 \cos(30\pi \times 10^6 t - 2\pi z) \hat{a}_y V/m.$

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

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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)

