CBCS SCHEME

USN | | | | | | | | | |

15EE45

Fourth Semester B.E. Degree Examination, Jan./Feb. 2023
Electromagnetic Field Theory

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define Divergence and Curl in Cartesian coordinate system with mathematical expressions. **(10 Marks)**

b. Define:
i) Electric Field intensity
ii) Gauss Law. **(06 Marks)**

OR

2 a. Find Curl $\bar{H}$ if $\bar{H} = (2\rho\cos\phi\,\bar{a}_\rho - 4\rho\sin\phi\,\bar{a}_\phi + 3\bar{a}_z)$. **(04 Marks)**

b. Identical point charges of 3μC are located at the four corners of the square of 5cm side, find the magnitude of force on any one charge. **(06 Marks)**

c. Derive an expression for field due to an infinite line charge using Gauss law. **(06 Marks)**

Module-2

3 a. Obtain the boundary condition between conductor and free space in an electric field. **(08 Marks)**

b. The potential field in free space is given by V = 50/r, $a \le r \le b$ (spherical).
i) Show that $\rho_v = 0$ for $a < r < b$
ii) Find the energy stored in the region $a < r < b$. **(08 Marks)**

OR

4 a. Potential is given by $V = 2(x+1)^2 (y+2)^2 (z+3)^2$ volts in free space. At a point P(2, -1, 4). Calculate: i) Potential ii) Electric Field Intensity. **(04 Marks)**

b. Show that the potential at the origin due to the uniform surface charge density ρ_s over a ring $z = 0$ and radius between $R < r < R + 1$, is independent of R. **(06 Marks)**

c. Obtain an expression for the energy stored in a capacitor. **(06 Marks)**

Module-3

5 a. From the Gauss's law derive Poisson's and Laplace's equation. **(08 Marks)**

b. Evaluate both sides of the Stoke's theorem for the field $H = 6xy\bar{a}_x - 3y^2\bar{a}_y$ A/m and the rectangular path around the region, $2 \le x \le 5$, $-1 \le y \le 1$, $z = 0$. Let the positive direction of $d\bar{s}$ be $\bar{a}z$. **(08 Marks)**

OR

6 a. State and explain Ampere's circuital law. **(04 Marks)**

b. Given the potential field $V = 3x^2yz + ky^3z$ volts:

i) Find K if potential field satisfies Laplace's equation.

ii) Find $\overline{E}$ at (1, 2, 3). **(06 Marks)**

c. Find the incremental field strength at P_2 due to the current element of $2\pi \bar{a}_z$ πAm at P_1. The co-ordinates of P_1 and P_2 are (4, 0, 0) and (0, 3, 0) respectively. **(06 Marks)**

Module-4

7 a. Define:

i) Magnetization

ii) Permeability. **(04 Marks)**

b. A current element 4cm long is along y-axis with a current of 10mA flowing in y-direction. Determine the force on the current element due to the magnetic field, if the magnetic field $H = [5a_x / \mu]A/m$. **(06 Marks)**

c. Derive an expression for the force on differential current carrying element. **(06 Marks)**

OR

8 a. Discuss the magnetic boundary conditions at the interface between two media of different permeabilities. **(08 Marks)**

b. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of 6cm diameter. The length of the tube is 60cm and the solenoid is in air. **(04 Marks)**

c. State Lorentz force equation. **(04 Marks)**

Module-5

9 a. Derive the wave equation for uniform plane wave propagation in perfect dielectric. **(08 Marks)**

b. A conductor 1cm in length is parallel to z-axis and rotates at radius of 25cm at 1200rpm. Find the induced voltage, if the radial field is given by $\overline{B} = 0.5\bar{a}_r$ T. **(08 Marks)**

OR

10 a. Obtain the solution of wave equation for uniform plane wave in free space. **(08 Marks)**

b. Calculate the induced e.m.f at t = 10sec. When the flux through each turn of a 200 turn coil is t(t-1)m wb. **(04 Marks)**

c. The magnetic field intensity of uniform plane wave in air is 20(A/m) in $\bar{a}_y$ direction. The wave is propagating in the $\bar{a}_z$ direction at an angular frequency of 2×10^9 (rad/sec). Find: i) Phase shift constant ii) Wave length. **(04 Marks)**

* * * * *