CBCS SCHEME

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18EE45

Fourth Semester B.E. Degree Examination, July/August 2022
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. Define Scalar and Vector, for a given two vectors : $\bar{A} = 2\bar{a}_x - 5\bar{a}_y - 4\bar{a}_z$ and $\bar{B} = 3\bar{a}_x + 5\bar{a}_y + 2\bar{a}_z$, solve to find the Dot product and angle between two vectors. **(08 Marks)**

b. Obtain the relationship between Rectangular and Cylindrical coordinates. **(06 Marks)**

c. Construct the Cartesian component of the vector, $H = 20a_r - 10a_\phi + 3a_z$ at $P(x=5, y=2, z=-1)$. **(06 Marks)**

OR

2 a. State and explain the Coulomb's law. **(06 Marks)**

b. Define Electric Field Intensity at a point. Derive an expression for field intensity due to infinite line charge. **(08 Marks)**

c. State and prove Gauss's law. **(06 Marks)**

Module-2

3 a. Show that Electric Field intensity is expressed as Negative Gradient of Scalar Potential. **(08 Marks)**

b. Calculate the potential at the centre of a square with a side a = 2 mtr, while charges 2 μC, $-4\,\mu C$, $6\,\mu C$ and 2 μC are located at its 4 corners. **(06 Marks)**

c. Define Electric dipole. Obtain the expression for potential and electric field intensity due to a dipole. **(06 Marks)**

OR

4 a. Derive the boundary conditions between a conductor and dielectric. **(08 Marks)**

b. Derive the continuity of current equation. **(06 Marks)**

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

Module-3

5 a. Derive the Poisson's and Laplace equations from Gauss law in point form in all the three co-ordinate system. **(08 Marks)**

b. State and explain Biot-Savart law and Ampere's circuital law. **(08 Marks)**

c. Solve to find the current density, given : $\bar{H} = (3y - z)\bar{a}_x + 2x\bar{a}_y$ A/m. **(04 Marks)**

OR

6 a. State and prove the Stoke's theorem. **(08 Marks)**

b. Verify the potential field, given satisfies the Laplace's equation, $V = r\cos\phi + z$. **(06 Marks)**

c. Derive the equation for point form of Ampere's law. **(06 Marks)**

Module-4

7 a. Derive an expression for force between two conductors carrying current in opposite direction. **(08 Marks)**

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

c. State and explain Lorentz force equation. **(06 Marks)**

OR

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

b. Derive an expression for inductance of solenoid. **(06 Marks)**

c. Given a ferrite material which will operate in a linear mode with B = 0.05 Tesla. Let $\mu_r = 50$. Calculate values of X_m, M and H. **(06 Marks)**

Module-5

9 a. State and explain Faraday's law. **(06 Marks)**

b. What are the drawbacks of Ampere's law? Hence derive an expression for modified ampere's law. **(08 Marks)**

c. Write Maxwell's equation in point form and integral form of time varying fields. **(06 Marks)**

OR

10 a. State and explain Poynting's theory with derivation $\overline{P} = \overline{E} \times \overline{H}$. **(08 Marks)**

b. The magnetic field intensity of uniform plane wave in air is 20 A/m in $\hat{a}_y$ direction. The wave is propagating in $\hat{a}_z$ direction at an angular frequency of 2×10^9 rad/sec. Find

(i) Phase shift constant.
(ii) Wavelength.
(iii) Frequency. **(06 Marks)**

c. Briefly explain the skin effect in conductors. **(06 Marks)**

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