CBCS SCHEME

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17EE45

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Two points A(2, 2, 1) and B(3, –4, 2) are given in the Cartesian system obtain the vector from A to B and a unit vector directed from A to B. **(06 Marks)**

b. Define divergence of a vector. What do positive and negative divergences represent. **(04 Marks)**

c. Derive the relationship between cylindrical and spherical coordinate systems. **(10 Marks)**

OR

2 a. State and explain coulomb's law of force between the two point charges. **(05 Marks)**

b. Define electric field intensity (E). Find an expression for electric field intensity due to N different point charges. **(07 Marks)**

c. State and explain Gauss law in electrostatics. **(08 Marks)**

Module-2

3 a. Define the following :
i) Potential difference and potential
ii) Potential gradient. **(06 Marks)**

b. Show that energy density in the electrostatic field is given by $\frac{1}{2}\vec{D}\cdot\vec{E}$ J/m^3. **(08 Marks)**

c. Given that the potential field is $V = 2x^2y - 5z$. Find the potential, electric field intensity and volume charge density at point P(–4, 3, 6). **(06 Marks)**

OR

4 a. With necessary relations, define current and current density. **(04 Marks)**

b. Explain the boundary conditions for a boundary between two di-electric materials. **(08 Marks)**

c. Derive an expression for the capacitance per unit length of a two wire transmission line. **(08 Marks)**

Module-3

5 a. Derive Poisson's and Laplace equations starting from point form of Gauss law. **(07 Marks)**

b. Verify that the potential field given below satisfies the Laplace's equation :
$V = 2x^2 - 3y^2 + z^2$. **(06 Marks)**

c. State and prove Uniqueness Theorem. **(07 Marks)**

OR

6 a. State and explain Biot-Savart's law. **(07 Marks)**

b. State and explain Stoke's theorem. **(06 Marks)**

c. Derive an expression for vector magnetic potential. **(07 Marks)**

Module-4

7 a. Derive an expression for the force between differential current elements. **(10 Marks)**

b. A point charge of Q = –1.2C has velocity $\bar{v} = (5\bar{a}_x + 2\bar{a}_y - 3\bar{a}_z)$ m/s. Find the magnitude of the force exerted on the charge if,

i) $\bar{E} = -18\bar{a}_x + 5\bar{a}_y - 10\bar{a}_z$ v/m

ii) $\bar{B} = -4\bar{a}_x + 4\bar{a}_y - 3\bar{a}_z$ T

iii) Both are present simultaneously. **(10 Marks)**

OR

8 a. Derive the boundary conditions at the interface between two magnetic materials of different permeabilities. **(10 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. **(03 Marks)**

c. Define mutual inductance. Derive an expression for mutual inductance of two different coils. **(07 Marks)**

Module-5

9 a. Explain briefly Faraday's law and displacement current for time varying fields. **(08 Marks)**

b. In a given lossy dielectric medium, conduction current density $J_C = 0.02 \sin 10t$ (A/m^2). Find the displacement current density if $\sigma = 10^3$s/m and $\varepsilon_r = 6.5$. **(05 Marks)**

c. Write Maxwell's equations in point form and in integral from for time varying fields. **(07 Marks)**

OR

10 a. Discuss the propagation of uniform plane waves in a lossless medium. **(07 Marks)**

b. Define poynting vector and explain the power flow associated with it. **(07 Marks)**

c. A 300MHz uniform plane wave propagates through fresh water for which $\sigma = 0$, $\mu_r = 1$ and $\epsilon_r = 78$. Calculate :

i) The attenuation constant

ii) The phase constant

iii) The wave length. **(06 Marks)**

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