CBCS SCHEME

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15EC36

Third Semester B.E. Degree Examination, June/July 2023
Engineering Electromagnetics

Time: 3 hrs. Max. Marks: 80

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

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.

Module-1

1 a. State and explain Coulomb's law in vector form. **(04 Marks)**

b. Point charges of 60 nano colombs each are located at A(2, 0, 0), B(-2, 0, 0), C(0, 2, 0) and D(0, -2, 0) in free space. Find the total force on the change at 'A'. **(08 Marks)**

c. Define electric field intensity and electric flux density and also establish the relationship between them. **(04 Marks)**

OR

2 a. Derive an expression for electric field intensity due to infinite line charge distribution. **(08 Marks)**

b. Find the electric field at the origin, if the following charge distributions are present in free space:

i) Point charge 15nc at P(1, 2, 3).

ii) Uniform line charge of $\rho_L = 3nc/m$ at x = 2, y = 3

iii) Uniform surface charge of $\rho_S = 0.2nc/m^2$ at x = 2. **(08 Marks)**

Module-2

3 a. State and prove Gauss law for point charge. **(05 Marks)**

b. Find the volume charge density at the point indicated.

$\vec{D} = 4\rho z \sin\phi \hat{a}_\rho + 2\rho z \cos\phi \hat{a}_\phi + 2\rho^2 \sin\phi \hat{a}_z \quad c/m^2$ at $p\left(1, \frac{\pi}{2}, 2\right)$ **(06 Marks)**

c. State and prove Gauss Divergence theorem. **(05 Marks)**

OR

4 a. Derive the expression for energy expended in moving a point charge in an uniform electric field in arbitrary direction. **(05 Marks)**

b. Let $V = \frac{\cos 2\phi}{r}$ in free space in cylindrical system. Find $\vec{E}$ at P(2, 30°, 1). **(06 Marks)**

c. Derive point form of continuity equation of current. **(05 Marks)**

Module-3

5 a. With the usual notations, deduce the poisons and Laplace equation from the Maxwell's for equation. **(04 Marks)**

b. Determine whether the following equations satisfy the Laplace equation or not.

i) $V = 2x^2 - 4y^2 + z^2$

ii) $V = r^2 \cos\phi + \theta$ **(06 Marks)**

c. State and prove uniqueness theorem. **(06 Marks)**

OR

6 a. State and explain Biot-Savart's law. **(04 Marks)**

b. Solve Laplace's equation to determine the capacitance of a coaxial cable when the inner radius is 'a' and outer radius is 'b' respectively. **(08 Marks)**

c. An air cored toroid having a cross sectional area of $6cm^2$ and mean radius 15cm is wound uniformly with 500 turns carrying a current of 4A. Determine the magnetic flux density. **(04 Marks)**

Module-4

7 a. Derive Lorentz force equation. **(06 Marks)**

b. A conductor 4m long lies along y axis with a current of 10A in the $\vec{a}_y$ direction. Find the force on the conductor if the field in the region is $\vec{B} = 0.008\ \vec{a}_x$ Tesla. **(04 Marks)**

c. Discuss the magnetic field boundary conditions using Maxwell's equations. **(06 Marks)**

OR

8 a. Derive an expression for the force on a differential current element placed in a magnetic field. **(06 Marks)**

b. Define: i) Magnetization ii) Permeability. **(04 Marks)**

c. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of length 60cm and of diameter 6cm, given that medium is air. Derive the expression used. **(06 Marks)**

Module-5

9 a. Explain displacement current density and conduction current density and write Maxwell's equation related to both. **(06 Marks)**

b. Find the frequency at which conduction current density and displacement current density are equal in a medium with $\alpha = 2 \times 10^{-4}$ ℧/m and $\varepsilon_r = 81$. **(04 Marks)**

c. State and prove poynting theorem. **(06 Marks)**

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OR

10 a. List Maxwell's equations in differential and integral form for both static and time varying fields. **(06 Marks)**

b. Derive the expression of α, β, γ and v_p for uniform plane wave in a good conductor. **(06 Marks)**

c. The depth of penetration in a certain conducting medium is 0.1m and the frequency of the electromagnetic wave is 1.0MHz. Find the conductivity of the conducting medium. **(04 Marks)**

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