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10ES36

Third Semester B.E. Degree Examination, June/July 2019
Field Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting atleast TWO questions from each part.***

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.

PART – A

1 a. Explain the electric field intensity and obtain the expression for electric field intensity at any point due to number of point charges. **(06 Marks)**

b. State and prove Gauss's Law and obtain the expression for Gauss divergence theorem. **(08 Marks)**

c. Evaluate both sides of the divergence theorem for the field $D = 2xy\ a_x + x^2 a_y\ c/m^2$ and the rectangular parallelpipe formed by the planes x = 0 and 1, y = 0 and 2 and z = 0 and 3. **(06 Marks)**

2 a. Explain the potential field of a system of charges and conservative property and also derive the potential field of a ring of uniform line charge density. **(08 Marks)**

b. Calculate the work done in moving a 3C charge from B(1, 0, 0) to A(0, 2, 0) along the path y = 2 – 2x, z = 0 in the field $5x\ a_x + 5y\ a_y$ v/m. **(05 Marks)**

c. Show that the electric field intensity is equal to the negative gradient of potential field in the electrostatic. **(07 Marks)**

3 a. Using the point form of Gauss's law, derive the expressions for Poisson's and Laplace's equations. **(06 Marks)**

b. Derive an expression for capacitance of the conical surface using spherical coordinates of the Laplace's equation for a potential function V = V(θ). **(08 Marks)**

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

4 a. Using Ampere's circuital law, derive the magnetic field intensity at different radial distances from the centre of the infinitely long coaxial cable and also draw the variation of magnetic field intensity as a function of radius. **(08 Marks)**

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

c. Given $A = (y \cos ax)a_x + (y + e^x)a$ find ∇XA at the origin. **(06 Marks)**

PART – B

5 a. Derive an expression for force on a differential current element and also obtain for the force between differential current elements. **(06 Marks)**

b. Derive an expression for torque on a closed circuit in terms of magnetic dipole moment and magnetic flux density. **(10 Marks)**

c. Calculate the self inductance of two coaxial solenoids of radius R_1 and R, $R_2 > R_1$ carrying currents I_1 and I_2 with n_1 and n_2 turns/m respectively. **(04 Marks)**

6 a. List the Maxwell's equations in point and integral forms. **(06 Marks)**
b. Write a short note on retarded potential and magnetic vector potential. **(06 Marks)**
c. Let $\mu = 10^5$ H/m, $\in = 4 \times 10^{-19}$ F/m, $\sigma = 0$ and $\rho_u = 0$. Find K so that each of the following pair of fields satisfier Maxwell's equation.

i) $\vec{D} = (6a_x - 2ya_y + 2za_z)n\ c/m^2$

$\vec{H} = (kxa_x + 10ya_y - 25za_z)\ A/m$

ii) $\vec{E} = (20y - kt)a_x\ \ V/m$

$\vec{H} = (y + 2\times10^6 t)a_3\ \ A/m$

(08 Marks)

7 a. Derive an expression for wave equation in free space. **(06 Marks)**
b. Given a non magnetic material having $\in_r^1 = 3.2$ and $\sigma = 1.5\times10^{-4}$ ℧/m, find numerical values at 3MHz for the i) Loss tangent ii) attenuation constant iii) phase constant iv) intrinsic impedance. **(08 Marks)**
c. Derive an expression for skin depth in good conductor. **(06 Marks)**

8 a. Derive the expression for reflection and transmission coefficients in terms of impedances when the uniform plane wave at normal incidence. **(08 Marks)**
b. A uniform plane wave in air partially reflects form the surface of a material. Measurements of the electric field in the region in front of the interface yield a 1.5m spacing between maxima, with the first maximum occurring 0.75m from the interface. A standing wave ratio of 5 is measured. Determine the intrinsic impedance η_u of the unknown material. **(06 Marks)**
c. Define standing wave ratio and obtain the expression for standing wave ratio in terms of reflection coefficient. **(06 Marks)**

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