USN | | | | | | | | | | | 10ES36

Third Semester B.E. Degree Examination, June/July 2013
Field Theory

Time: 3 hrs. Max. Marks: 100

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

PART – A

1 a. State and prove Gauss's Divergence theorem. **(06 Marks)**

b. State and explain the electric field intensity and obtain an expression for electric field intensity due to an infinitely long line charge. **(08 Marks)**

c. A charge of -0.3 μC is located at A(25, -30, 15) cm, and a second charge of 0.5 μC at B(-10, 8, 12) cm. Find E at i) the origin ii) P(15, 20, 50) cm. **(06 Marks)**

2 a. Discuss with relevant equations the potential field of a system of charges and hence obtain the potential field of a ring of uniform line charge density. **(08 Marks)**

b. Discuss current and current density and derive the expression for continuity equation. **(06 Marks)**

c. Given the field $E = 40\, xya_x + 20x^2a_y + 2a_z$ V/m, calculate the potential between the two points P(1, -1, 0) and Q(2, 1, 3). **(06 Marks)**

3 a. State and prove the uniqueness theorem. **(08 Marks)**

b. Derive Poisson's and Laplace's equations. **(05 Marks)**

c. Calculate numerical values for V and S_V at point P in free space if $V = \dfrac{4yz}{x^2+1}$ at P(1, 2, 3). **(07 Marks)**

4 a. Derive an expression for magnetic field intensity at a point P due to an infinitely long straight filament carrying a current I. Also obtain the magnetic field intensity caused by a finite length current filament on the z-axis. **(08 Marks)**

b. In an infinitely long coaxial cable carrying a uniformely current I in the inner conductor and –I in the outer conductor, find the magnetic field intensity is a function of radius and sketch the field intensity variation. **(07 Marks)**

c. Discuss the scalar and vector magnetic potentials. **(05 Marks)**

PART – B

5 a. Discuss the force on a differential current element and also obtain the expression for force. **(08 Marks)**

b. Given a ferrite material which we shall specify to be operating in a linear mode with B = 0.05 T, let us assume $\mu_r = 50$, and calculate values for x_m, M and H. **(06 Marks)**

c. Define inductance and derive the expression for inductance of a torodial coil of N turns and a current I. **(06 Marks)**

6 a. List the Maxwell's equations in point and integral forms for time varying field. **(06 Marks)**

b. Explain the retarded potentials. **(08 Marks)**

c. Let $\mu = 10^5$ H/m, $\in = 4 \times 10^{-9}$ F/m, $\sigma = 0$ and $S_V = 0$. Find K so that each of the following pair of fields satisfies Maxwell's equations:

i) $D = (6a_x - 2ya_y + 2za_z nC/m^2)$

$H = (Kxa_x + 10ya_y - 25za_z)$ A/m

ii) $E = (20y - Kt)a_x$ V/m

$H = (y + 2 \times 10^6 t)\ a_z$ A/m **(06 Marks)**

7 a. Starting from Maxwell's equations, obtain the wave equations in free space. **(07 Marks)**

b. Derive an expression for depth of penetration. **(07 Marks)**

c. Find the depth of penetration at a frequency of 1.6 MHz in aluminium, where $\sigma = 38.2$ Mz/m and $\mu_r = 1$. Also find γ, λ and V_P. **(06 Marks)**

8 a. Derive the expressions for reflection and transmission coefficients for normal incidence at the boundary between two dielectrics. **(09 Marks)**

b. Write a note on standing wave ratio. **(06 Marks)**

c. A uniform plane wave in air partially reflects from the surface of a material whose properties are unknown. Measurements of the electric field in the region in front of the interface yield a 1.5 m spacing between maxima, with the first maximum occurring 0.75 m from the interface. A standing wave ratio of 5 is measured. Determine the intrinsic impedance η_u of the unknown material. **(05 Marks)**

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