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06ES36

Third Semester B.E. Degree Examination, June / July 08
Field Theory

Time: 3 hrs. Max. Marks:100

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

PART - A

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

b. Two point charges of magnitudes 2 mc and –7 mc are located at places $P_1(4, 7, -5)$, and $P_2(-3, 2, -9)$ respectively in free space, evaluate the vector force on charge at P_2. **(06 Marks)**

c. From Gauss Law show that $\nabla.\hat{D} = \rho_v$. **(10 Marks)**

2 a. Find the potentials at $\gamma_A = 5m$ and $\gamma_B = 15m$ due to a point charge Q = 500 pc placed at the origin. Find the potential at $\gamma_A = 5m$ assuming zero as potential at infinity. Also obtain the potential difference between points A and B. **(06 Marks)**

b. Derive an expression for the potential of co-axial cable in the dielectric space between inner and outer conductors. **(06 Marks)**

c. Discuss the boundary conditions between two perfect dielectrics. **(08 Marks)**

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

b. From the Gauss's law obtain Poisson's and Laplace's equation. **(06 Marks)**

c. Determine whether or not the following potential fields satisfy Laplace's equation –

i) $V = x^2 - y^2 + z^2$, ii) $V = r\cos\phi + z$. **(06 Marks)**

4 a. Using Biot – Savart law find an expression for the magnetic field of a straight filamentary conductor carrying current 'I' in the Z – direction. **(08 Marks)**

b. Given the magnetic field $H = 2r^2(Z+1)\sin\phi\hat{a}_\phi$, verify Stokes theorem for the portion of a cylindrical surface defined by $r = 2$, $\frac{\pi}{4} < \phi < \pi/2$, $1 < Z < 1.5$ and for its perimeter. **(08 Marks)**

c. With necessary expressions, explain scalar magnetic potential. **(04 Marks)**

PART - B

5 a. Find the expression for the force on a differential current carrying elements. **(06 Marks)**

b. Find the normal component of the magnetic field which traverses from medium 1 to medium 2 having $\mu_{r_1} = 2.5$ and $\mu_{r_2} = 4$. Given that $\hat{H} = -30\hat{a}_x + 50\hat{a}_y + 70\hat{a}_z$ v/m. **(06 Marks)**

c. Derive an expression for the self inductance of a co – axial cable. **(08 Marks)**

6 a. For a closed stationary path in space linked with a changing magnetic field prove that $\nabla \times \hat{E} = \frac{-\partial \hat{B}}{\partial t}$, where $\hat{E}$ is the electric field and $\hat{B}$ is the magnetic flux density. **(08 Marks)**

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

c. List the Maxwell's equations in differential and integral form as applied to time varying fields. **(08 Marks)**

7 a. Starting from Maxwell's equation, derive the wave equation for a uniform plane wave traveling in free space. **(08 Marks)**

b. A 300 MHz uniform plane wave propagates through fresh water for which $\alpha = 0$, $\mu_r = 1$ $\epsilon_r = 78$. Calculate i) attenuation constant ii) phase constant iii) wave length iv) intrinsic impedance. **(06 Marks)**

c. Explain the skin depth. Determine the skin depth for copper with conductivity of 58×10^6 s/m at a frequency of 10 MHz. **(06 Marks)**

8 a. Show that at any instant t, the magnetic and electric field in a reflected wave are out of phase by 90^0. **(10 Marks)**

b. With necessary expression, explain standing wave ratio (SWR). **(10 Marks)**