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10ES36

Third Semester B.E. Degree Examination, Dec.2013/Jan.2014
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 explain the Coulomb's law of force between the two point charges. **(05 Marks)**

b. Four 10nc positive charges are located in the Z = 0 plane at the corners of a square of side 8cm. A fifth 10nc positive charge is located at a point 8cm distant from the other charges. Calculate the magnitude of the force on the fifth charge in free space. **(07 Marks)**

c. A 100nc point charge is located at A(-1, 1, 3) in free space.
   i) Find the locus of all points P(x, y, z) at which E_x = 500 V/m.
   ii) Find y_1 it P(-2, y_1, 3) lies on that locus. **(08 Marks)**

2 a. Determine the work done in carrying a charge of 2C from B(1, 0, 1) to A(0.8, 0.6, 1) in an-electric field $\vec{E} = y\hat{a}_y + x\hat{a}_y + 2\hat{a}_z$ V/mt along the short arc of circle $x^2 + y^2 = 1$, Z = 1. **(06 Marks)**

b. Show that electric field intensity is a negative potential gradient. **(04 Marks)**

c. Derive an expression for continuity equation in point form. **(04 Marks)**

c. The Z = 0 defines the boundary between free space and dielectric medium with dielectric constant 20. The electric field intensity in free space is $\vec{E} = 10\hat{a}_x + 20\hat{a}_y + 40\hat{a}_z$ V/mt. Determine the electric field intensity in the dielectric medium. **(06 Marks)**

3 a. Derive Poisson's and Laplace's equation. **(06 Marks)**

b. In free space the volume charge density $\rho_v = \frac{200\epsilon_0}{r^{2.4}} C/m^3$, use Poisson's equation to find the potential V(r). **(08 Marks)**

c. Using Laplace's equation derive an expression for capacitance of parallel plate capacitor. **(06 Marks)**

4 a. State and explain Biot-Savart law. **(06 Marks)**

b. Prove that Ampere's circular law $\vec{\nabla} \times \vec{H} = \vec{J}$. **(07 Marks)**

c. Determine the magnetic field intensity $\vec{H}$ at point P(0.4, 0.3, 0). If the 8A current in a conductor inward from ∞ to orgin on the x-axis and outward to ∞ along y-axis. **(07 Marks)**

PART – B

5 a. Deduce the expression for force between the differential current elements. **(10 Marks)**

b. A loop has a dimension of 1mt × 2mt and lies in the uniform magnetic field $\vec{B}_0 = -0.6\hat{a}_y + 0.8\hat{a}_z$ T. The loop current is 4mA. Calculate the torque on the loop. **(10 Marks)**

6 a. Using Faraday's law derive an expression for emf induced in a stationary conductor placed in a time varying magnetic field. **(04 Marks)**

b. In a certain dielectric media the relative permittivity $\epsilon_r = 5$, conductivity $\sigma = 0$, the displacement current density $\vec{J}_d = 20\cos(1.5\times10^8 t - bx)\hat{a}y \ \mu A/m^2$. Determine the electric flux density and electric field intensity. **(06 Marks)**

c. Show that, in a capacitor the conduction current density is equal to displacement current density for the applied voltage of $v(t) = v_0 \cos wt$. **(10 Marks)**

7 a. Using Maxwell's equation derive an expression for uniform plane wave in free space. **(08 Marks)**

b. Derive an expression for propagation constant, intrinsic impedance and phase velocity in good conducting media if the uniform plane wave is propagating. **(06 Marks)**

c. The $\vec{H}$ field in free space is given by $\vec{H}(x,t) = 10\cos(10^8 t - \beta x)\hat{a}y \ A/mt$. Find β, λ and E(x, t) at P(0.1, 0.2, 0.3) and t = 1ns. **(06 Marks)**

8 a. Derive an expression for reflection and transmission coefficient if the uniform plane wave incident normally at the boundary with different dielectric. **(10 Marks)**

b. Write a short note on Poynting theorem. **(10 Marks)**

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