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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 if $P(-2, y_1, 3)$ 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 $\vec{E} = y\hat{a}_y + x\hat{a}_x + 2\hat{a}_z$ 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/m³, 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 origin 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 \times 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)

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.

- 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 $\vec{J}_d = 20 \cos(1.5 \times 10^8 t - \beta x) \hat{a}_y \mu A/m^2$. 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 $v(t) = v_0 \cos \omega t$. (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/m. Find β , λ and $E(x, t)$ at $P(0.1, 0.2, 0.3)$ and $t = 1$ ns. (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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