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06ES36

Third Semester B.E. Degree Examination, December 2011

Field Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least 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. State vector form of Coulomb's law of force between two point charges and indicate the units of quantities in the force equation. **(06 Marks)**

b. State and prove Gauss's law for point charge. **(06 Marks)**

c. A line charge of 2 nc/m lies along y-axis while surface charge densities of 0.1 nc/m^2 and $-0.1 nc/m^2$ exist on the plane z = 3 and z = -4m respectively. Find the $\overline{E}$ at P(1, 7, -2). **(08 Marks)**

2 a. Define potential difference and potential, and establish the relation $\overline{E} = -\nabla V$. **(06 Marks)**

b. Obtain boundary conditions for perfect dielectric materials in electrostatic field. **(06 Marks)**

c. Let $V = \frac{\cos 2\phi}{r}$ in the free space, in cylindrical system. Find :

i) $\overline{E}$ at A(2, 30°, 1)

ii) ρ_v at B(0.5, 60°, 1) **(08 Marks)**

3 a. Derive the expressions for Poisson's and Laplace's equation. **(04 Marks)**

b. By applying Laplace's equation, find the expression for capacitance between the two concentric spheres. Make suitable assumptions. **(08 Marks)**

c. Given the potential field $V = [Ar^4 + Br^{-4}]\sin 4\phi$:

i) Show that $\nabla^2 V = 0$.

ii) Find A and B such that V = 100V and $|\overline{E}| = 500$ V/m at P(r = 1, $\phi = 22.5°$, z = 2). **(08 Marks)**

4 a. State and explain Biot Savart law. **(04 Marks)**

b. State and prove Ampere's circuital law. By applying it obtain expression for $\overline{H}$ due to infinitely long straight conductor. **(08 Marks)**

c. Find the magnetic flux density at the centre 'o' of a square of sides equal to 5m and carrying 10 amperes of current. **(08 Marks)**

PART – B

5 a. Derive an expression for magnetic force on :

i) Moving point charge and

ii) Differential current element. **(10 Marks)**

b. Two differential current elements, $I_1\Delta\overline{L}_1 = 10^{-5}\overline{a}_z$ A.m. at $P_1(1, 0, 0)$ and $I_2\Delta\overline{L}_2 = 10^{-5}(0.6\overline{a}_x - 2\overline{a}_y + 3\overline{a}_z)$ A.m. at $P_2(-1, 0, 0)$ are located in free space. Find vector force exerted on $I_2\Delta\overline{L}_2$ by $I_1\Delta\overline{L}_1$. **(10 Marks)**

6 a. Write the Maxwell's equations in point form. **(04 Marks)**

b. For a closed stationary path in space linked with a changing magnetic field prove that $\nabla \times \bar{E} = -\frac{\partial \bar{B}}{\partial t}$. **(08 Marks)**

c. Determine the value of K such that following pairs of fields satisfies Maxwell's equation in the region where $\sigma = 0$ and $\rho_v = 0$.

$$\bar{E} = [Kx - 100t]\bar{a}_y \text{ V/m} \qquad \bar{H} = [x + 20t]\bar{a}_z \text{ A/m}$$
$$\mu = 0.25 \text{ H/m}, \qquad \varepsilon = 0.01 \text{ F/m}$$
(08 Marks)

7 a. Derive general wave equations in terms of $\bar{D}$ and $\bar{B}$ in uniform medium using Maxwell's equations. **(08 Marks)**

b. A 300 MHz uniform plane wave propagates through (lossless med.) fresh water for which $\sigma = 0$, $\mu r = 1$ and $\varepsilon r = 78$. Calculate : i) α, ii) β, iii) λ, iv) η. **(08 Marks)**

c. Define : i) Poynting's theorem and ii) Skin effect. **(04 Marks)**

8 a. Define SWR and write the relation between SWR and transmission coefficient (Γ). **(04 Marks)**

b. Define transmission and reflection coefficients and derive the expressions for τ and Γ in terms of η. **(08 Marks)**

c. Find ratio $\left(\frac{E_r}{E_i}\right)$ and $\left(\frac{E_t}{E_i}\right)$ at the boundary for the normal incidence if for the region 1; $\varepsilon_{r_1} = 8.5$, $\mu_{r_1} = 1$ and $\sigma_1 = 0$ and if region 2 is free space. **(08 Marks)**

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