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10EE44

Fourth Semester B.E. Degree Examination, June/July 2015
Field Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Define electric field intensity at a point. A point charge of 6 μc is located at (0, 0, 1), the uniform line charge of density e_L = 180 nC/m is along x – axis and uniform sheet charge with e_s = 25 nC/m^2 over the plane z = –1. Find the combined elastic field intensity at p(1, 5, 2) due to all the charges. **(08 Marks)**

b. Derive differential form of Gauss's law. **(06 Marks)**

c. Let $\vec{D} = 5r^2 \hat{a}_r \quad D < r < 0.08\text{m}$

$= \frac{0.1}{r^2} \hat{a}_r \quad \text{for } r > 0.08\text{m}$

i) Find the charge density for r = 0.06 m
ii) Find the charge density for r = 0.1 m. **(06 Marks)**

2 a. Derive the relation between electric field intensity and electric potential. **(06 Marks)**

b. Explain the boundary conditions for a boundary between two electric materials. **(08 Marks)**

c. If V = x – y + xy + zy volts, find the electric field intensity at a point (1, 2, 3) and the energy stored in a cube of scale 2m. **(06 Marks)**

3 a. Derive Poisson's and Laplace's equations. **(04 Marks)**

b. Solve the Laplace and equation for the potential field in the homogenous region between the two concentric conducting spheres with radii 'a' and 'b' (a < b). The potential v = 0 at r = b and v = v_0 at r = a. Also find the capacitance between them. **(10 Marks)**

c. State and prove uniqueness theorem. **(06 Marks)**

4 a. State Biot-Savart law and use it to obtain the magnetic flux density at a point on the axis of a current carrying solenoid. **(06 Marks)**

b. Derive the expression $\nabla \times \vec{H} = \vec{J}$ **(08 Marks)**

c. Given the field $\vec{H} = \frac{x+2y}{z^2}\hat{a}_y + \frac{2}{z}\hat{a}_x$ A/m. find the total current passing through the surface z = 4 ; 1 < x < 2 ; 3 < y < 5. **(06 Marks)**

PART – B

5 a. Explain the boundary conditions between two magnetic materials. **(08 Marks)**

b. Derive an expression for vector magnetic potential. **(06 Marks)**

c. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of length 60 cms and of diameter 6 cms. Derive the expression used. **(06 Marks)**

6 a. Derive the point form Faraday's law. **(08 Marks)**

b. Do the fields $\vec{E} = E_m \sin x \sin t \ \hat{a}_y$ V/m

and $\vec{H} = \frac{E_m}{\mu_0} \cos x \cos t \ \hat{a}_z$ A/m satisfy Maxwell's equations. **(06 Marks)**

c. Establish the equivalence of conduction current and displacement current. **(06 Marks)**

7 a. Derive the relation between $\vec{E}$ and $\vec{H}$ for a uniform plane wave propagating in a conducting medium. **(08 Marks)**

b. Derive expressions for attenuation constant (α) and phase constant (β) for an electromagnetic wave. **(06 Marks)**

c. A uniform plane wave $E_y = 10 \sin(2\pi \times 10^8 t - \beta x)$ V/m is propagating in x – direction. Find the phase constant, phase velocity and the magnetic field component. **(06 Marks)**

8 a. State and prove Poynting's theorem. **(08 Marks)**

b. Determine the amplitude of reflected and transmitted fields (both E and H) at the interface of two dielectric regions. Given E_i = 1.5 mV/m in region – 1, $\epsilon_{r_1} = 1$, $\mu_{r_1} = 1$; $\epsilon_{r_2} = 8.5$, $\mu_{r_2} = 1$. **(06 Marks)**

c. Write a short note on standing wave ratio (SWR). **(06 Marks)**

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