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10ES36

Third Semester B.E. Degree Examination, December 2011
Field Theory

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define electric field intensity due to point charge in a vector form. With usual notations derive expressions for field at a point due to many charges. **(06 Marks)**

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

c. Given $\vec{D} = 30e^{-r}\hat{a}_r - 2z\hat{a}_z \, c/mt^2$. Verify divergence theorem for the volume enclosed by $r = 2, z = 5$. **(08 Marks)**

2 a. Derive an expression for energy and energy density in an electrostatic field. **(04 Marks)**

b. A 15 nc point charge is at the origin in free space. Calculate v_1 if point P is located at P(–2, 3, –1) and : i) V = 0 at (6, 5, 4) ii) V = 0 at infinity. **(08 Marks)**

c. If $\vec{E} = -8xy\hat{a}_x - 4x^2\hat{a}y + \hat{a}_z$ v/m, find the work done in carrying a 6C charge from A(1, 8, 5) to B(2, 18, 6) along the path $y = 3x + 2, z = x + 4$. **(08 Marks)**

3 a. Starting with point form of Gauss law deduce Poisson's and Laplace's equations. **(06 Marks)**

b. Use Laplace's equation to find the capacitance per unit length of a co–axial cable of inner radius 'a' m and outer radius 'b' m. Assume $V = V_0$ at $r = a$ and $V = 0$ at $r = b$. **(08 Marks)**

c. Determine whether or not the potential equations :
$V = 2x^2 - 4y^2 + z^2$ ii) $V = r^2 \cos\phi + \theta$ iii) $V = r\cos\phi + z$
satisfy the Laplace's equation. **(06 Marks)**

4 a. Starting from Biot–Savart law, derive an expression for the magnetic field intensity at a point due to finite length of current carrying conductor. **(06 Marks)**

b. Calculate the value of vector current density at P(1.5, 90°, 0.5) if $\vec{H} = \frac{2}{r}\cos 0.2\phi \, \hat{a}_r$. **(04 Marks)**

c. Evaluate both sides of the Stoke's theorem for the field $\vec{H} = 6xy\,\hat{a}_x - 3y^2\,\hat{a}_y$ A/m and the rectangular path around the region $2 \le x \le 5, -1 \le y \le 1, z = 0$. **(10 Marks)**

PART – B

5 a. Obtain boundary conditions at the interface between two magnetic materials. **(06 Marks)**

b. A circular loop of 10 cm radius is located in xy plane with magnetic field $\vec{B} = 0.5\cos(377t)[3\hat{a}_y + 4\hat{a}_z]$ T. Calculate the voltage induced by the loop. **(06 Marks)**

c. A single trun circular coil 5 cm diameter carries a current of 2.8 A. Determine the magnetic flux density $\vec{B}$ at a point on the axis 10 cm from the center. Derive the formula used. **(08 Marks)**

6 a. What is displacement current and equation of continuity? Derive Maxwell's equation for Ampere's circuit law. **(06 Marks)**

b. Determine whether or not the following pairs of fields satisfy Maxwell's equation.

$$\vec{E} = E_m \sin x \sin t \, \hat{a}_y \quad v/m$$

$$\vec{H} = \frac{E_m}{\mu} \cos x \cos t \, \hat{a}_z \quad v/m$$

(06 Marks)

c. A parallel plate capacitor with plate area 5 cm^2 and plate separation of 3 mm has a voltage of 50 sin 10^3 t volts applied to its plates. Calculate the displacement current assuming $\epsilon = 2 \epsilon_0$. **(08 Marks)**

7 a. For an electromagnetic wave propagating in free space prove that $\frac{|\vec{E}|}{|\vec{H}|} = \eta$. **(08 Marks)**

b. State and explain Poynting's theorem. **(06 Marks)**

c. Calculate intrinsic impedance η, propagation constant γ and wave velocity v for a conducting medium in which $\sigma = 58$ MS/m, $\mu_r = 1$, $\epsilon_r = 1$ at frequency of 100 MHz. **(06 Marks)**

8 a. Define standing wave ratio. What is its relationship with the reflection co–efficient? **(08 Marks)**

b. A uniform plane wave of 200 MHz travelling in a free space impinges normally on a large block of material having $\epsilon_r = 4$, $\mu_r = 9$, $\sigma = 0$. Calculate transmission and reflection coefficients at the interface. **(06 Marks)**

c. With usual notations, obtain the general wave equations for electric and magnetic fields. **(06 Marks)**

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