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06EE44

Fourth Semester B.E. Degree Examination, June-July 2009
Field Theory

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. State and explain experimental law of Coulomb. **(05 Marks)**

b. Identical point charges of 3μC are located at the four corners of the square of 5cm side, find the magnitude of force on any one charge. **(08 Marks)**

c. Using Gauss law, determine electric field intensity every where due to a hollow sphere of charge. **(07 Marks)**

2 a. Obtain an expression for the energy expanded in moving a point charge in an electric field. **(05 Marks)**

b. Potential is given by $V = 2(x+1)^2(y+2)^2(z+3)^2$ volts in free space. At a point P(2, –1, 4) calculate i) Potential ii) Electric field intensity iii) Flux density and iv) Volume charge density. **(08 Marks)**

c. Obtain boundary conditions for dielectric-dielectric boundary. **(07 Marks)**

3 a. Explain Poisson's equation & Laplace equation. **(05 Marks)**

b. Given the potential field $V = [Ar^4 + Br^{-4}] \sin 4\phi$ volts. Show that $\nabla^2 v = 0$, select A & B so that v = 100 volts and $|\bar{E}| = 500$ v/m at P(r = 1, $\phi = 22.5°$, z = 2). **(08 Marks)**

c. State and prove Uniqueness theorem. **(07 Marks)**

4 a. Using Biot Savart's law, obtain magnetic field intensity expression due to an infinite length conductor carrying current I. **(05 Marks)**

b. Derive the general expression for the field $\bar{B}$ at any point along the axis of a solenoid. **(08 Marks)**

c. Define vector magnetic potential. Prove that $A = \int_v \frac{\mu_0 J dv}{4\pi R}$. **(07 Marks)**

PART – B

5 a. Derive Lorentz force equation and mention the application of the solution. **(05 Marks)**

b. Derive an expression for the force on a differential current element placed in a magnetic field. Find the force per meter length between two long parallel wires separated by 10cm in air and carrying a current of 10A in the same direction. **(08 Marks)**

c. Derive differential form of continuity equation. **(07 Marks)**

6 a. What is the inconsistency of Ampere's law with the equation of continuity? Derive the modified form of Ampere's law of Maxwell. **(05 Marks)**

b. Given $\bar{E} = E_0 \sin(\omega t - \beta z)\vec{a}y$ v/m in free space. Find i) $\bar{D}$ ii) $\bar{B}$ iii) $\bar{H}$. Sketch $\bar{E}$ & $\bar{H}$ at t = 0. **(08 Marks)**

c. Write Maxwell's equation in point form and in integral form for time varying fields. **(07 Marks)**

7 a. Define wave equation. Derive the wave equation for $\vec{E}$ in a general medium. **(05 Marks)**

b. For an electromagnetic wave propagating in free space, prove that

i) $\frac{|\vec{E}|}{|\vec{H}|} = \eta$ ii) $\vec{E}$ & $\vec{H}$ are mutually perpendicular **(08 Marks)**

c. State and prove Poynting theorem. **(07 Marks)**

8 a. Define 'depth' of penetration'. Show that depth of penetration of a wave in a conductor decreases with an increase in frequency. **(05 Marks)**

b. Show that at any instant the magnetic and electric field in a reflected wave are out-of phase by 90°. **(08 Marks)**

c. Define Brewster's angle. Derive the necessary expression in terms of permittivity. **(07 Marks)**