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06ES36

Third Semester B.E. Degree Examination, May/June 2010
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. Explain the term 'Electric field intensity' and derive the expression for field due to an infinite line of charge. **(12 Marks)**

b. Given $\vec{D} = 5r\hat{a}_r\ c/m^2$, prove divergence theorem for a shell region enclosed by spherical surfaces at r = a and r = b (b>a) and centered at the origin. **(08 Marks)**

2 a. Prove that the energy density in an electrostatic field is given by $\frac{1}{2} \in \vec{E}^2\ J/m^3$. **(08 Marks)**

b. Given $V = 2x^2y - 5z$ at point P(-4, 3, 6). Find the potential, electric field intensity and volume charge density. **(08 Marks)**

c. Derive the boundary conditions for $\vec{E}$ and $\vec{D}$ between two dielectrics. **(04 Marks)**

3 a. State and prove uniqueness theorem. **(10 Marks)**

b. Derive the expression for capacitance of a coaxial cable using Laplace's equation. **(10 Marks)**

4 a. State and explain Biot-Savart law for a small differential current element. **(04 Marks)**

b. Derive the expression for magnetic flux density on the axis of a circular loop of radius 'a' carrying current I using Biot Savart law. **(07 Marks)**

c. Vector magnetic potential in free space is given by $\vec{A} = 100e^{1.5}\hat{a}_z$ Wb/m. Find the magnetic field intensity and current density and hence prove Ampere's circuital law for $\rho = 1$. **(09 Marks)**

PART – B

5 a. Deduce the expression for inductance of a toroidal coil having N turns and carrying a current of I amps. **(06 Marks)**

b. A point charge Q = 18 nC has a velocity of 5×10^6 m/s in the direction $\hat{a} = 0.6\hat{a}_x + 0.75\hat{a}_y + 0.3\hat{a}_z$. Calculate the magnitude of the force exerted on the charge by the field $\vec{B} = -3\hat{a}_x + 4\hat{a}_y + 6\hat{a}_z$ mT. **(06 Marks)**

c. A sq. loop carrying 2 mA current is placed in the field of an infinite filament carrying current of 15 Amp as shown, fig. Q5 (c). Find the force exerted on the sq.loop. **(08 Marks)**

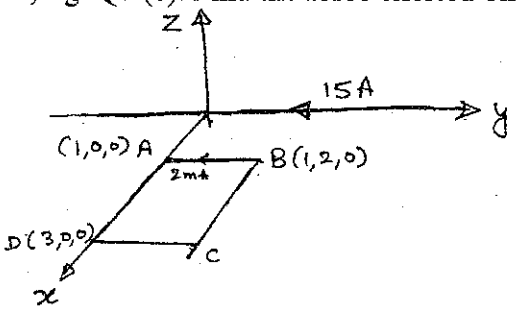

Fig. Q5 (c)

6 a. What do you mean by displacement current and equation of continuity? Derive Maxwell's I equation fro Ampere's circuital law. **(08 Marks)**

b. Write Maxwell's equations in point form and integral form. **(06 Marks)**

c. A 9.375 GHz uniform plane wave is propagating in polyethylene ($\epsilon_r = 2.26$). If the amplitude of the $\vec{E}$ is 500 V/m and the material is assumed to be lossless, find

i) Phase constant ii) Wavelength iii) Velocity of propagation

iv) Intrinsic impedance v) Magnetic field intensity **(06 Marks)**

7 a. What is meant by 'uniform plane wave'? Derive the expression for UPW in free space. **(07 Marks)**

b. Deduce the expressions for α and β for a wave traveling in lossy medium. **(07 Marks)**

c. A 100 V/m wave of frequency 300 MHz is traveling through a lossy medium having $\epsilon_r = 9$, $\mu_r = 1$ and $\sigma = 10$ S/m. Find the power dissipated over a distance of 1 μm with surface area of 2 m^2. **(06 Marks)**

8 Write short notes on:

a. Poynting's theorem.

b. Reflection of plane waves at normal incidence. **(20 Marks)**

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