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10EE44

Fourth Semester B.E. Degree Examination, June/July 2016
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. State Gauss theorem of electrostatics. List characteristics of Gaussian surface. **(05 Marks)**

b. Determine electric flux density 'D' in Cartesian coordinates caused at p(6, 8, –10) by i) a point charge of 30 mc at origin ii) infinite line charge with $\rho_r = 40\ \mu c/m$ ii) A surface charge with $\rho_s = 57.2\ \mu c/m^2$ on a plane z = – 9m. **(08 Marks)**

c. Evaluate both side of divergence theorem for the region $r \le a$ (spherical coordinates) having flux density $D = \frac{5r}{3} a_r\ c/m^2$ **(07 Marks)**

2 a. Prove that : $E = -\nabla V$ **(05 Marks)**

b. Determine work done in carrying a charge of –2C from (2, 1, –1) to (8, 2, –1) in an electric field $E = ya_x + xa_y$ v/m along the path $x = 2y^2$. **(07 Marks)**

c. Three point charges 3 coul, 4 coul and 5 coul are to be situated at corner of an equilateral triangle of side 5 m. Find energy density at the centre of triangle. **(08 Marks)**

3 a. Derive Poisson's and Laplace equation. **(06 Marks)**

b. A potential field is given by $v = x^2yz + Ay^3z$ volts determine of 'A' such that v satisfies Laplace equation and hence find electric field E at p(2, 1, –1). **(06 Marks)**

c. A spherical capacitor has a capacitance of 54 pF. It consists of two concentric spheres with inner and outer radii differing by 4 cm. Dielectric in between is air. Determine inner and outer radii. **(08 Marks)**

4 a. State and explain Ampere's circuital law. **(05 Marks)**

b. Determine magnetic flux density 'B' at 'P' for a current loop shown in Fig.Q4(b). **(09 Marks)**

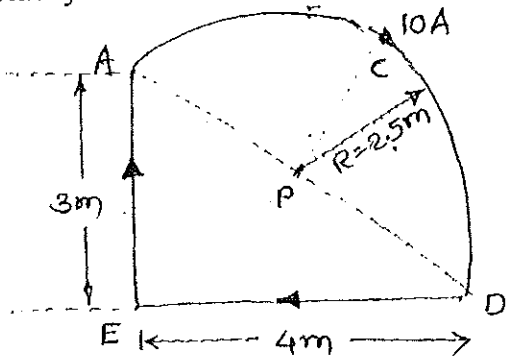

Fig. Q4(b)

c. Clearly distinguish between scalar magnetic potential and vector magnetic potential. **(06 Marks)**

PART – B

5 a. Derive Lorentz force equation for a moving change placed in a combined electric and magnetic field. **(06 Marks)**

b. A point charge Q = 18 nc moves with a velocity of 5×10^6 m/sec in the direction of $0.06a_x + 0.75a_y + 0.3a_z$. Determine magnitude of force experienced by the charge when placed in i) electric field $E = -3a_x + 4a_y + 6a_z$ kv/m ii) magnetic field $E = -3a_x + 4a_y + 6a_z$ mT iii) combined E and B. **(08 Marks)**

c. An air cored toroid has a cross sectional area of 6 cm^2, a mean radius of 15 cm and is wound with 500 turns and carries a current of 4A. Find the magnetic field intensity at the mean radius. **(06 Marks)**

6 a. Explain Faraday's laws applied to : i) stationary path, changing field and ii) steady field, moving circuit. **(06 Marks)**

b. List Maxwell's equations for both : i) steady and ii) Time varying fields in differential and integral form, also mention the relevant laws they demonstrate. **(08 Marks)**

c. A straight conductor of length 0.2m, lies on x-axis with one end at origin. The conductor is subjected to a magnetic flux density $B = 0.04a_y$ Tesla and the velocity $v = 2.5 \sin 10^3 t\, a_z$ m/sec. Determine motional emf induced in the conductor. **(06 Marks)**

7 a. Derive wave equation for E in a general medium. **(06 Marks)**

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

c. A lossless dielectric medium has $\sigma = 0$, $\mu_r = 1$ $\varepsilon_r = 1$. A electromagnetic wave has field as $H = -0.1 \cos(\omega t - z)a_x + 0.5 \sin(\omega t - z)a_y$ A/m. Find : i) phase constant, ii) angular velocity iii) the wave impedance iv) components of electric field intensity of the wave. **(08 Marks)**

8 a. Derive an expression for transmission coefficient and reflection coefficient and relate them. **(08 Marks)**

b. Define standing wave ratio. Write an expression for it. **(04 Marks)**

c. Determine the amplitude of reflected and transmitted 'E' and 'H' at the interface between two regions. Characteristics of region 1 are $\varepsilon_{r1} = 8$, $\mu_{r1} = 0$; $\sigma_1 = 0$ and region 2 is free space. The incident E_0^i in region 1 is of 1.5 V/m. Assume normal incidence. Also find average power in two regions. **(08 Marks)**

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