USN

06ES36

Third Semester B.E. Degree Examination, June 2012

Field Theory

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer FIVE full questions, selecting at least TWO questions from each part.***
2. Assume any missing data suitably.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Define and explain electric field intensity. State principle of superposition and find electric field intensity due to multiple point charge distribution. **(06 Marks)**

b. State Gauss law and use it to determine electric field intensity due to an infinitely long line charge. **(08 Marks)**

c. A cube of 4m centered at origin with edges parallel to the coordinate axes of Cartesian co-ord system. If $\overline{D}$ (electric flux density) $= \frac{20x^5}{5}\hat{a}x$ C/m^2, what is the total charge contained in the cube. **(06 Marks)**

2 a. Discuss boundary condition at the interface of conductor and dielectric material in case of electric field. **(08 Marks)**

b. Starting from the principle of line integral find capacitance of a co-axial capacitor for a < r < b, in which capacitor has length ‘L’ m inner conductor has radius ‘a’ m, and outer conductor has radius ‘b’ m. **(06 Marks)**

c. The current density due flow of charges in a very small region in the viscinity of the origin is given by $J = J_o\left[x^2\hat{a}_x + y^2\hat{a}_y + z^2\hat{a}_z\right]$ A/m^2, where J_o is a constant. Find the time rate of increase of charge density at each of the following points (all in meters):
i) (0.02, 0.01, 0.01) ii) (0.02, -0.01, -0.01). **(06 Marks)**

3 a. Starting from Gauss’ law in point form, derive Poisson and Laplace equations. **(04 Marks)**

b. Long concentric and right conducting cylinders in free space at r = 5mm and r = 25mm in cylindrical co-ordinates have voltages of zero and V_o respectively. If the electric field intensity $\overline{E}$=-8.28 ∗ 10^3 $\hat{a}r$ V/m at r = 15mm, starting from Laplace equation find V_o and charge density on the outer conductor [Take $\in = \in_o$ = 8.854 ∗ 10^{s} F/m]. **(08 Marks)**

c. Two parallel conducting discs are separated by distance 5mm at Z = 0; and Z = 5mm. V = 0 at Z = 0; and V = 100 volts at Z = 5mm and it is only in Z direction. Starting from Laplace equation find surface charge densities on the discs. [Take $\in = \in_o$ = 8.854 ∗ 10^{-12} F/m]. **(08 Marks)**

4 a. State Biot-Savart law and use this to find magnetic field intensity at a point ‘P’ due to an infinite length filament carrying current I and placed on Z-axis. Point P is at a distance ‘r’ m from origin. **(08 Marks)**

b. In a Co-axial line, radius of inner conductor is ‘a’ m, inner radius of outer conductor is ‘b’ m and outer radius of outer conductor is ‘c’ m. Inner and outer conductors carry current I and -I respectively. Using Ampere circuit law, find magnetic field intensity for r < a; a < r < b; b < r < c; r > c cases. Sketch the variation of field intensity versus distance. **(08 Marks)**

c. Find the magnetic flux density $\left(\left|\overline{B}\right|\right)$ at the center of a square conductor of each side equal to 5m and carrying a current of 10A. Take $\mu = 4\pi * 10^{-7}$ H/m. **(04 Marks)**

PART – B

5 a. Derive the boundary conditions for magnetic flux density (B), magnetic field intensity (H) at the interface between two different magnetic materials. **(08 Marks)**

b. Find the magnetic field intensity within a magnetic material for the following cases with $\mu_o = 4\pi * 10^{-7}$ H/m.

i) Magnetization M = 180 A/m, permeability $\mu_r = 1.8 * 10^{-5}$ H/m

ii) Magnetic flux density $|B| = 450 * 10^{-6}$ Tesla and (Chi m) $\chi_m = 15$. **(06 Marks)**

c. A toroidal coil of 500 turns is wound on a steel ring of 0.5m mean diameter and $2 * 10^{-3}$ m^2 cross sectional area. An excitation of 4000 A/m produces a flux density of 1 Tesla. Find inductance of coil. **(06 Marks)**

6 a. State and explain Farday's law of electromagnetic induction. Hence obtain Maxwell's equation in differential form. **(04 Marks)**

b. Explain concept of displacement current in capacitor. **(04 Marks)**

c. Determine whether following pair of fields satisfy Maxwell's equations in the region $\sigma = 0$; $\in = 02.5\in_o$ and $\mu = 10\ \mu_o$

(i) $\overline{E} = 3y\ \hat{a}_y$ and $\overline{H} = 4x\ \hat{a}_x$. **(12 Marks)**

7 a. With suitable assumption work out the solution of wave equation for uniform plane wave propogating in a good conductor. **(10 Marks)**

b. A 10GHz plane wave travelling in free space has an amplitude of 15V/m. Find:

i) Velocity of propogation.

ii) Wave length.

iii) Characteristic impedance.

iv) Amplitude of $\overline{H}$.

v) Propogation constant (β). **(05 Marks)**

c. Determine the depth of penetration for copper at 3MHz frequency. The conductivity for copper is $58 * 10^{7}$ s/m and permeability (μ) is $1.26 * 10^{-6}$ H/m (1.26 μ H/m). **(05 Marks)**

8 a. Write a note on Brewster angle in wave propogation. **(04 Marks)**

b. Derive an expression for reflection coefficient and transmission coefficient for normal incidence at another dielectric in wave propogation. **(10 Marks)**

c. Find reflection coefficient and transmission coefficient of an electric field wave traveling in air and incident normally on a boundary between air and dielectric having permeability equal to μ_o and permittivity $\in_r = 4.74$. **(06 Marks)**

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