

**Third Semester B.E. Degree Examination, December 2010**  
**Field Theory**

Time: 3 hrs.

Max. Marks:100

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

**PART - A**

- 1 a. Show that the electric field intensity at a point, due to 'n' number of point charges, is given by
 
$$\vec{E} = \frac{1}{4\pi\epsilon_0} \sum_{i=1}^n \frac{Q_i}{R_i^2} \hat{a}_{R_i} \text{ v/m.} \quad (05 \text{ Marks})$$
- b. A uniform line charge of infinite length with  $\rho_L = 40 \text{ nc/m}$ , lies along the z-axis. Find  $\vec{E}$  at (-2, 2, 8) in air. (05 Marks)
- c. State and prove the Gauss's law. (06 Marks)
- d. Determine the volume charge density, if the field is  $\vec{D} = \frac{10 \cos \theta \sin \phi}{r} \hat{a}_r \text{ c/m}^2$ . (04 Marks)
  
- 2 a. Derive an equation for the potential at a point, due to an infinite line charge. (06 Marks)
- b. If the potential field  $V = 3x^2 + 3y^2 + 2z^3$  volts, find  
i) V ii)  $\vec{E}$  iii)  $\vec{D}$  at P(-4, 5, 4) (06 Marks)
- c. Deduce an equation for the capacitance of a coaxial cable of length 'L', radius of inner conductor 'a' and out conductor 'b'. (08 Marks)
  
- 3 a. State and prove the uniqueness theorem. (06 Marks)
- b. Find the capacitance between the two concentric spheres of radii  $r = b$  and  $r = a$ , such that  $b > a$ , if the potential  $V = 0$  at  $r = b$ , using the Laplace's equation. (10 Marks)
- c. Determine whether or not the potential equations i)  $V = 2x^2 - 4y^2 + z^2$  and ii)  $V = r^2 \cos \phi + \theta$  satisfy the Laplace's equation. (04 Marks)
  
- 4 a. State and prove the Stoke's theorem. (04 Marks)
- b. If the magnetic field intensity in a region is  $\vec{H} = (3y - 2)\hat{a}_z + 2x\hat{a}_y$ , find the current density at the origin. (06 Marks)
- c. A co-axial cable with radius of inner conductor a, inner radius of outer conductor b and outer radius c carries a current I at inner conductor and -I in the outer conductor. Determine and sketch variation of  $\vec{H}$  against r for i)  $r < a$  ii)  $a < r < b$  iii)  $b < r < c$  iv)  $r > c$ . (10 Marks)

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 – B

- 5 a. Derive an equation for the force between the two differential current elements. (06 Marks)
- b. Derive the magnetic boundary conditions at the interface between the two different magnetic materials. Discuss the conditions. (08 Marks)
- c. Calculate the inductance of a solenoid of 400 turns wound on a cylindrical tube of 10 cm diameter and 50 cm length. Assume the solenoid is in air. (06 Marks)
- 6 a. Using the Faraday's law, deduce the Maxwell's equation, to relate time varying electric and magnetic fields. (08 Marks)
- b. Derive the Maxwell's equations in the point form of the Gauss's law for time varying fields. (06 Marks)
- c. Given  $\vec{E} = E_m \sin(\omega t - \beta z) \hat{a}_y$  in free space. Find  $\vec{D}$ ,  $\vec{B}$  and  $\vec{H}$ . (06 Marks)
- 7 a. Obtain the solution of wave equation for uniform plane wave in free space. (10 Marks)
- b. State and explain the Poynting's theorem. (04 Marks)
- c. For a wave traveling in air, the electric field is given by  $\vec{E} = 6 \cos(\omega t - \beta t) \hat{a}_z$  at  $f = 10$  MHz. Calculate the average Poynting vector. (06 Marks)
- 8 a. Explain the reflection of uniform plane waves, with normal incidence at a plane dielectric boundary. (10 Marks)
- b. Write short notes on:
- i) Standing wave ratio.
  - ii) Skin effect in conductors.
- (10 Marks)

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