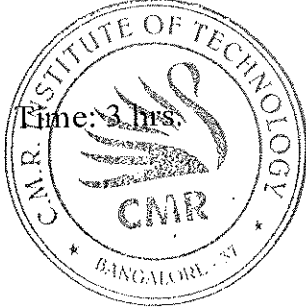


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10ES36

**Third Semester B.E. Degree Examination, June/July 2016**  
**Field Theory**



Max. Marks: 100

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

**PART - A**

- 1
  - a. Three point charges  $Q_1 = -1 \mu\text{C}$ ,  $Q_2 = -2 \mu\text{C}$  and  $Q_3 = -3 \mu\text{C}$  are placed at the corners of an equilateral triangle of side 1 m. Find the magnitude of the electric field intensity at the point bisecting the joining  $Q_1$  and  $Q_2$ . (07 Marks)
  - b. Derive an expression for the electric field intensity due to infinite line charge. (08 Marks)
  - c. Let  $\vec{D} = (2y^2z - 8xy)\hat{a}_x + (4xyz - 4x^2)\hat{a}_y + (2xy^2 - 4z)\hat{a}_z$ . Determine the total charge within a volume of  $10^{-14} \text{ m}^3$  located at  $P(1, -2, 3)$ . (05 Marks)
- 2
  - a. Infinite number of charges each of  $Q \text{ nC}$  are placed along x axis at  $x = 1, 2, 4, 8, \dots, \infty$ . Find the electric potential and electric field intensity at a point  $x = 0$  due to the all charges. (06 Marks)
  - b. Find the work done in assembling four equal point charges of  $1 \mu\text{C}$  each on x and y axis at  $\pm 3\text{m}$  and  $\pm 4\text{m}$  respectively. (06 Marks)
  - c. Derive the expression for a capacitance of a parallel plate capacitor. (08 Marks)
- 3
  - a. Explain Poisson's and Laplace's equations. (06 Marks)
  - b. Find  $\vec{E}$  at  $P(3, 1, 2)$  for the field of two co-axial conducting cylinders  $V = 50 \text{ V}$  at  $\rho = 2 \text{ m}$  and  $V = 20 \text{ V}$  at  $\rho = 3 \text{ m}$ . (08 Marks)
  - c. Using Poisson's equation obtain the expression for the potential in a p-n junction. (06 Marks)
- 4
  - a. An infinite filament on the z-axis carries  $20\pi \text{ mA}$  in the  $\hat{a}_z$  direction. Three uniform cylindrical sheets are also present,  $400 \text{ mA/m}$  at  $r = 1 \text{ cm}$ ,  $-250 \text{ mA/m}$  at  $r = 2 \text{ cm}$ ,  $400 \text{ mA/m}$  at  $r = 3 \text{ cm}$ . Calculate  $H_\phi$  at  $r = 0.5, 1.5$  and  $2.5 \text{ cm}$  in cylindrical co-ordinates. (10 Marks)
  - b. If the vector magnetic potential at a point in a space is given as  $\vec{A} = 100\rho^{1.5}\hat{a}_z \text{ wb/m}$ , find the following : (i)  $\vec{H}$  (ii)  $J$  and show that  $\oint \vec{H} \cdot d\vec{c} = I$  for the circular path with  $\rho = 1$ . (10 Marks)

**PART - B**

- 5
  - a. A conductor 4 m long lies along the y-axis with a current of 10.0 A in the  $\hat{a}_y$  direction. Find the force on the conductor if the field in the region is  $\vec{B} = 0.005 \hat{a}_z \text{ Tesla}$ . (04 Marks)
  - b. Discuss the boundary between two magnetic materials of different permeabilities. (08 Marks)
  - c. A solenoid with air core has 2000 turns and a length of 5000 mm. Core radius is 40 mm. Find its inductance. (08 Marks)

- 6 a. Find the frequency at which conduction current density and displacement current density are equal in a medium with  $\sigma = 2 \times 10^{-4} \text{ U/m}$  and  $\epsilon_r = 81$ . (04 Marks)
- b. Given  $\vec{H} = H_m e^{j(\omega t + \beta z)} \hat{a}_x$  A/m in free space. Find  $\vec{E}$ . (06 Marks)
- c. Explain the concept of retarded potential. Derive the expressions for the same. (10 Marks)
- 7 a. The magnetic field intensity of uniform plane wave in air is 20 A/m in  $\hat{a}_y$  direction. The wave is propagating in the  $\hat{a}_z$  direction at an angular frequency of  $2 \times 10^9$  rad/sec. Find:  
 (i) Phase shift constant (ii) Wavelength  
 (iii) Frequency (iv) Amplitude of electric field intensity. (08 Marks)
- b. Explain electromagnetic wave in Good conductor. (08 Marks)
- c. The depth of penetration in a certain conducting medium is 0.1 m and the frequency of the electromagnetic wave is 1.0 MHz. Find the conductivity of the conducting medium. (04 Marks)
- 8 a. Derive the expression for transmission co-efficient and reflection co-efficient. (08 Marks)
- b. Define standing wave ratio. What value of S results is reflection coefficient equals  $\pm \frac{1}{2}$ ? (06 Marks)
- c. Given  $\gamma = 0.5$ ,  $\eta_1 = 100 (\Omega)$ ,  $\eta_2 = 300 (\Omega)$ ,  $E'_{x_1} = 100$  (V/m). Calculate values for the incident, reflected and transmitted waves. Also show that the average power is conserved. (06 Marks)

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