



**Third Semester B.E. Degree Examination, June/July 2017**

**Field Theory**

Time: 3 hrs.

Max. Marks:100

**Note: Answer FIVE full questions, selecting at least TWO questions from each part.**

**PART - A**

1. a. Drive the expression for electric field intensity [EFI] due to infinite line charge. (08 Marks)  
 b. A point charge  $Q_1 = 25 \text{ nc}$  is located at  $P_1(4, -2, 7)$  and a charge  $Q_2 = 60 \text{ nc}$  is at  $P_2(-3, 4, 2)$ , if  $\epsilon = \epsilon_0$ , find: i)  $\vec{E}$  at  $P_3(1, 2, 3)$  and (ii) At which point on the 'y' axis is  $E_x = 0$ ? (06 Marks)  
 c. A cube is defined by  $1 < x, y, z < 1.2$ . If  $\vec{D} = 2x^2y \vec{a}_x + 3x^2y^2 \vec{a}_y \text{ c/m}^2$ .  
 i) Apply Gauss's law to find the total flux leaving the closed surface of the cube.  
 ii) Evaluate  $\nabla \cdot \vec{D}$  at the centre of the cube.  
 iii) Estimate the total charge enclosed within the cube. (06 Marks)
2. a. Find the workdone in moving a charge of  $+2\text{C}$  from  $(2, 0, 0)\text{m}$  to  $(0, 2, 0)\text{m}$  along the straight line path joining the two points. If the electric field is  $\vec{E} = 2x \vec{a}_x - 4y \vec{a}_y \text{ V/m}$ . (08 Marks)  
 b. Prove that  $\vec{E} = -\nabla V$ . (06 Marks)  
 c. A potential field in free space is expressed as  $V = \frac{20}{xyz}$  volts.  
 i) Find the total energy stored within the cube  $1 < x, y, z < 2$ .  
 ii) What value of the energy would be obtained by assuming a uniform energy density equal to the value at the centre of the cube? (06 Marks)
3. a. Let  $\epsilon = \epsilon_0$ , and  $V = 90 Z^{\frac{4}{3}}$  in the region  $z = 0$ .  
 i) Obtain expression for  $\vec{E}$ ,  $\vec{D}$  and  $\rho_v$  as function of  $\vec{Z}$ .  
 ii) If the velocity of charge density is given as  $V_z = 5 \times 10^{-6} Z^{\frac{2}{3}} \text{ m/s}$ . Find  $I_z$  at  $z = 0$  and  $z = 0.1 \text{ m}$ . (06 Marks)  
 b. Derive boundary condition at a boundary between two dielectric medium. (08 Marks)  
 c. Determine whether or not the following potential fields satisfy the Laplace equation:  
 i)  $V = x^2 - y^2 + z^2$       ii)  $V = r \cos \phi + z$  (06 Marks)
4. a. Find the magnetic field intensity ( $\vec{H}$ ) due to straight conductor of finite length using Biot-Savart law. (06 Marks)  
 b. Using Biot-Savart law, find the value of  $\vec{H}$  at that point p for the current circuit shown in Fig.Q4(b).

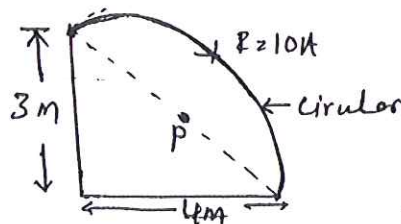


Fig.Q4(b)

- c. Define and derive expression for scalar magnetic potential and vector magnetic potential. (08 Marks)

**PART – B**

- 5 a. Explain force between differential current elements. (06 Marks)  
 b. Explain the magnetic boundary conditions. (08 Marks)  
 c. Define self inductance. Derive expression for the inductance of a co-axial cable. (06 Marks)
- 6 a. Derive Maxwell's equation in vector differential form for time varying field starting from Faraday's law. (06 Marks)  
 b. Derive an expression for general wave equation in free space. (08 Marks)  
 c. An uniform plane wave of 1 MHz is propagating in medium for which  $\sigma = 5.8 \times 10^7 \text{ } \Omega/\text{m}$  and  $\epsilon_r = \mu_r = 1$ . Find the following:  
 i) Attenuation constant  
 ii) Phase shift constant  
 iii) Velocity  
 iv) Wavelength (06 Marks)
- 7 a. State and prove Poynting theorem. (10 Marks)  
 b. The region  $Z < 0$  is characterized by  $\epsilon'_R = \mu_R = 1$  and  $\epsilon''_R = 0$ . The total  $\bar{E}$  field here is given as the sum of the two uniform plane waves:  $E_s = 150e^{-j10z}\bar{a}_x + (50\angle 20^\circ)e^{j10z}\bar{a}_x \text{ V/m}$ .  
 Find:  
 i) What is the operating frequency?  
 ii) Specify the intrinsic impedance of the region  $Z > 0$  that would provide the appropriate reflected wave.  
 iii) At what value of  $Z(-10\text{cm} < z < 0)$  is the total electric field intensity a maximum amplitude? (10 Marks)
- 8 a. Define SWR and derive the expression for SWR in term of reflection coefficient. (10 Marks)  
 b. Explain reflection of uniform plane waves at normal incidence, derive the expressions for transmission and reflection coefficient. (10 Marks)

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