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10ES36

# Third 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. Three point charges $Q_1 = -1$ μc, $Q_2 = -2$ μc and $Q_3 = -3$ μc 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 $10^{-14}$ m$^3$ located at P(1, –2, 3). **(05 Marks)**

2 a. Infinite number of charges each of Qnc are placed along x axis at x = 1, 2, 4, 8,.....∞. 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 μc each on x and y axis at ±3m and ±4m 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 V at ρ = 2 m and V = 20 V at ρ = 3m. **(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 20π mA in the $\hat{a}_z$ direction. Three uniform cylindrical sheets are also present, 400 mA/m at r = 1 cm, - 250 mA/m at r = 2 cm, 400 mA/m at r = 3m. Calculate $H_\phi$ at r = 0.5, 1.5 and 2.5 cm in cylindrical co-ordinates. **(10 Marks)**

b. If the vector magnetic potential at a point in a space is given as $\vec{A} = 100\rho^{1.5}\hat{a}_z$ wb/m, find the following : (i) $\vec{H}$ (ii) J and show that $\oint \vec{H}.d\vec{c} = I$ for the circular path with ρ = 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 $\vec{B} = 0.005\ \hat{a}_z$ 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 $\sigma = 2\times10^{-4}$ ℧/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 $2\times10^9$ 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 ± ½? **(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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