ACHARYA INSTITUTE OF TECHNOLOGY
Bangalore - 560090

USN | | | | | | | | | | |

10EE44

Fourth Semester B.E. Degree Examination, Dec.2016/Jan.2017
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. State and explain Coulomb's law in vector form. **(05 Marks)**

b. Two point charges $Q_1 = -0.3nC$ at [25, –30, –15], and $Q_2 = 0.5nC$ at [–10, 8, 12] present in free space determine $\vec{E}$ at P(15, 20, 50). **(05 Marks)**

c. Given $D = 4y^2 \hat{a}_x + 3x^2 y \hat{a}_y + 15\hat{a}_z \, C/m^2$ verify both sides of Divergence theorem and evaluate charge enclosed within region $0 < x, y, z < 2$. **(10 Marks)**

2 a. Find out the work done in moving a charge $\rho = a$ to $\rho = b$ along with radial direction due to infinite line charge. **(06 Marks)**

b. Given a potential $V = 3x^2 + 4y^2(V)$, find the energy stored in volume described by $0 \le x \le 1m$, $0 \le y \le 1m$ and $0 \le z \le 1m$. **(06 Marks)**

c. Obtain the boundary condition between conductor and free space. **(08 Marks)**

3 a. State and prove uniqueness theorem. **(08 Marks)**

b. In spherical co-ordinates V = 0 at r = 0.1 m and V = 100 V at r = 2m. Assuming free space between the concentric spherical shell find $\vec{E}$ and $\vec{D}$. **(06 Marks)**

c. Use Laplace equation to find the capacitance between two plate of a parallel plate capacitor, separated by distance 'd" and maintained at potential "o" and "V_0" respectively. **(06 Marks)**

4 a. Find the magnetic field intensity and flux density at the centre, of a circular wire carrying a current 'I' and of radius 'a' by using Biot – Savart's law. **(06 Marks)**

b. In cylindrical co-ordinates a magnetic field is given as $\vec{H} = [4\rho - 2\rho^2]\hat{a}_\phi \, A/m \; 0 \le \rho \le 1$

i) Find the current density as a function of ρ within the cylinder

ii) Find the total current that passes through the surface $z = 0$ and $0 \le \rho \le 1m$ in $\hat{a}_z$ direction. **(06 Marks)**

c. Define vector magnetic potential and prove that $A = \frac{\mu_0}{4\pi}\int_v \frac{J}{r} \cdot dv$. **(08 Marks)**

PART – B

5 a. Derive an expression for the force between two differential current elements. **(06 Marks)**

b. The z = 0 marks the boundary between two magnetic materials. For region 1, $(z > 0)$, $\mu_1 = 4$ μH and region 2, $(z < 0)$, $\mu_2 = 6$ μH. The surface current density at the boundary is given as $\vec{K} = 12\hat{a}_y \, A/m$, find $\vec{H}_2$ if $\vec{H}_1 = 40\hat{a}_x + 50\hat{a}_y + 12\hat{a}_z \, kA/m$. **(06 Marks)**

c. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical type of length 60 cm and of diameter 6 cm. Given that the medium is air. Derive the expression used. **(08 Marks)**

6 a. List Maxwell's equations for time varying field in point and integral form. **(06 Marks)**

b. Starting from Ampere's circuital law derive an expression for displacement current density for time varying fields. **(06 Marks)**

c. What is retarded potential? Obtain an expression for retarded potential V and A. **(08 Marks)**

7 a. State and prove Poynting's theorem. **(10 Marks)**

b. With respect to wave propagation in good conductors, describe what is skin effect, derive an expression for the depth of penetration. If $\sigma = 58 \times 10^6$ ℧/m at frequency 10 MHz determine depth of penetration. **(10 Marks)**

8 a. The plane x = 0 is the boundary between two perfect dielectric. For $x < 0$, $\mu_1 = \mu_0$, $\varepsilon_1 = 3.6\pi$ pf/m and $\sigma_1 = 0$; for $x > 0$, $\mu_2 = \mu_0$, $\varepsilon_2 = 14.4\pi$ pf/m and $\sigma_2 = 0$.

If $E_i^+ = 60\cos(10^9 t - \beta_1 x)V/m$ find :

i) Incident magnetic field H_i

ii) Reflected electric and magnetic field E_r and H_r

iii) Transmitted electric and magnetic field E_t and H_t **(10 Marks)**

b. What is a standing wave? Derive an expression for standing wave ratio. **(10 Marks)**

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