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

10EE44

Fourth Semester B.E. Degree Examination, Dec.2015/Jan.2016

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. Explain the terms "electric field intensity" and derive expression for field due to infinite line of charge. **(08 Marks)**

b. Use Gauss law to determine electric field intensity due to infinite line charge. **(06 Marks)**

c. The flux density $\bar{D} = \frac{r}{3}\,\bar{a}_r \text{ nc/m}^2$ is in the free space.

i) Find $\bar{E}$ at r = 0.2m
ii) Find the total Electric flux leaving the sphere of r = 0.2m
iii) Find the total charge within the sphere of r = 0.3m. **(06 Marks)**

2 a. Show that the energy required to assemble 'n' number of point changes is $W_E = \frac{1}{2}\sum_{m=1}^{n} Q_m V_m$ and hence derive expression form energy in electric field in terms of field quantities $\bar{D}$ and $\bar{E}$. **(08 Marks)**

b. Potential is given by $V = 2(x+1)^2 (y+2)^2 (z+3)^2$ volts in free space. At a point P(2, -1, 4). Calculate i) Potential ii) Electric field intensity iii) Flux density and iv) Volume charge density. **(06 Marks)**

c. Find the work done in moving a charge of +2C from (2, 0, 0)m to (0, 2, 0)m along the straight line path joining two points, if the electric field is $\bar{E} = \left(12x\bar{a}_x - 4y\bar{a}_y\right)$ v/m. **(06 Marks)**

3 a. Arrive at the Poisson's equation in Cartesian coordinates. Deduce Laplace's equation from Poisson's equation. **(06 Marks)**

b. Verify that the potential field $V = 2x^2 - 3y^2 + z^2$ satisfies the Laplace's equation. **(06 Marks)**

c. Using Laplace equation, derive the expression for the capacitance of a co – axial cable. **(08 Marks)**

4 a. State and explain Biot – Savart's law. Using this, find the magnetic field intensity in the vicinity of an infinitely long, straight, filamentary current I Amperes along Z – axis. **(08 Marks)**

b. Discuss the concept of vector magnetic potential and hence show that $\bar{A} = \frac{\mu_0}{4\pi}\int \frac{\bar{J}}{4} dv$ where $\bar{A}$ is the vector magnetic potential and $\bar{J}$ is the current density. **(06 Marks)**

c. At a point P(x, y, z) the components of vector magnetic potential $\bar{A}$ are given as $A_x = 4x + 3y + 2z$, $A_y = 5x + 6y + 3z$ and $A_z = 2x + 3y + 5z$. Determine $\bar{B}$ at point P and state its nature. **(06 Marks)**

PART – B

5 a. State and explain the Lorentz force equation. **(06 Marks)**

b. A conductor 4m long lies along the y – axis with a current of 10A in the $\bar{a}_y$ direction. Find the force on the conductor if the field in the region is $\bar{B} = 0.005\,\bar{a}_x$, Tesla. **(06 Marks)**

c. Discuss the boundary conditions at the interface between two media of different permeabilites. **(08 Marks)**

6 a. Show that

$$\nabla \bullet \bar{J} = \frac{-\partial \rho v}{\partial t}$$

Where $\bar{J}$ = conduction current density A/m^2

ρ = volume charge density in cm^3 **(08 Marks)**

b. Find the induced voltage in the conductor if $\bar{B} = 0.04\,\bar{a}_y$ T and

$\bar{V} = 2.5 \sin 10^3 t\,\bar{a}_z$ m/s

Find induced e.m.f if $\bar{B}$ is changed to $0.04\,\bar{a}_x$ T. **(12 Marks)**

7 a. Derive the wave equation starting from Maxwell's equation for free space. **(10 Marks)**

b. A lossy dielectric has $\mu_r = 1$, $\varepsilon_r = 50$ and $\sigma = 60$ $\mho$/m at 15.9MHz. Find α, β, V and η if the uniform plane wave is travelling through the medium. **(10 Marks)**

8 a. Derive the expression for transmission coefficient and reflection coefficient. **(10 Marks)**

b. With necessary expression, explain standing wave ratio. **(10 Marks)**

* * * * *