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

06ES36

Third Semester B.E. Degree Examination, June/July 2011
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. State and explain Gauss law as applied to an electric field. **(05 Marks)**

c. Let a point charge $Q_1 = 25$ nc be located at A(4, -2, 7) and a charge $Q_2 = 60$ nc be at B(-3, 4, -2). Find $\vec{E}$ at C(1, 2, 3). Also find the direction of the electric field. Given $\epsilon_0 = 8.854 \times 10^{-12}$ F/m. **(10 Marks)**

2 a. Derive the boundary conditions to be satisfied at eh interface between a dielectric and a conductor in a static electric field. **(08 Marks)**

b. Obtain the expression for the work done in bringing a charge 'Q' from one point to another point along the radial path in an electric field due to an infinite line charge. Hence find the potential difference between that two points. **(06 Marks)**

c. Given the vector current density

$$\vec{J} = 10\rho^2 z\,\vec{a}_\rho - 4\rho\cos^2\phi\,\vec{a}_\phi \text{ mA/m}^2$$

Find the current flowing outward through the circular band $\rho = 3$, $0 < \phi < 2\pi$, $2 < z < 2.8$. **(06 Marks)**

3 a. Starting with point form of Gauss law deduce Poisson's and Laplace's equations. **(04 Marks)**

b. Using Poisson's equation obtain the expression for the junction potential in a P – n junction. **(08 Marks)**

c. Find E at P(3, 1, 2) for the field of two co-axial conducting cylinders V = 50 V at $\rho = 2$m, V = 20 V at $\rho = 3$ m. **(08 Marks)**

4 a. Obtain the expression for the magnetic flux density at any point on the axis of a circular current loop of n turns. **(07 Marks)**

b. State and prove stokes theorem. **(07 Marks)**

c. Calculate the value of the vector current density at point P(2, 3, 4) if

$$\vec{H} = x^2 z\,\vec{a} - y^2 x\,\vec{a}_z$$ **(06 Marks)**

PART – B

5 a. Derive the expression for the torque on a rectangular current loop carrying current I. **(07 Marks)**

b. Obtain the expression for reluctance in a series magnetic circuit. **(05 Marks)**

c. The point charge Q=18 nc has a velocity of 5×10^6 m/s in the direction $\vec{a}_v = 0.6\vec{a}_x + 0.75\vec{a}_y + 0.3\vec{a}_z$. Calculate the force exerted on the charge Q by the field $\vec{B} = -3\vec{a}_x + 4\vec{a}_y + 4\vec{a}_z$ mT. **(05 Marks)**

d. A coil of 500 turns is wound on a closed iron ring of mean radius 0.10 m and cross section area 3×10^{-4} m^2. Find the self inductance of the winding if the relative permeability of iron is 800. Give : $\mu_0 = 4\pi \times 10^{-7}$ H/m. **(03 Marks)**

6 a. Derive the integral and differential form of Faraday's law. **(07 Marks)**

b. Modify the Ampere's circuital law to suit the time varying condition. **(06 Marks)**

c. For the given medium $\epsilon = 4 \times 10^{-9}$ F/m and $\sigma = 0$. Find 'k' so that the following pair of fields satisfy Maxwell's equations.

$$\vec{E} = (20y - kt)\vec{a_x}\ V/m$$

$$\vec{H} = (y + 2\times10^6 t)\vec{a_z}\ A/m$$

(07 Marks)

7 a. Starting from Maxwell's equations obtain the general wave equations in electric and magnetic fields. **(10 Marks)**

b. A uniform plane wave with 10 MHz frequency has average pointing vector 1 w/m^2. If the medium is perfect dielectric with $\mu_r = 2$ and $\epsilon_r = 3$, $\mu_0 = 4\pi \times 10^{-7}$ H/m, $\epsilon_0 = 8.854 \times 10^{-12}$ F/m;

Find:

i) Velocity

ii) Wavelength

iii) Intrinsic impedance

iv) rms value of electric field. **(10 Marks)**

8 a. Explain the reflection of plane waves at the surface of dielectrics at normal incidence. Hence derive the expression for reflection coefficient and transmission coefficient. **(10 Marks)**

b. A uniform plane wave at 100 MHz with electric field amplitude of 5 V/m travels in a medium of $\sigma = 0$, $\mu_r = 1$, $\epsilon_r = 9$. The wave propagates in x – y plane at 30° angle to x – axis. It is linearly polarized along z – axis. Write the phasor expression for electric field. Also determine values of λ_x, λ_y, v_{px}, v_{py}. Given $\mu_0 = 4\pi \times 10^{-7}$ H/m, $\epsilon_0 = 8.854 \times 10^{-12}$ F/m. **(10 Marks)**

* * * * *