USN | | | | | | | | | | EC44

Fourth Semester B.E. Degree Examination, June /July 08
Field Theory

Time: 3 hrs. Max. Marks:100

Note : *Answer any FIVE full questions.*

1 a. State and explain inverse square law for electric field in the vector form. Mention the units of each term involved. **(06 Marks)**

b. Four positive point charges of 40 nc each are located at A (2, 0, 0), B (-2, 0, 0), C (0, 2, 0) and D (0, -2, 0). Find the total force $\overline{F}$ and electric field intensity $\overline{E}$ at A. **(07 Marks)**

c. Define electric field intensity. Obtain an expression for the electric field intensity $\overline{E}$ due to an infinite line charge along Z – axis having a uniform charge density ρ_L c/m. using Coulomb's law. **(07 Marks)**

2 a. State Gauss's law. Using Gauss's law obtain an expression for electric field intensity $\overline{E}$ due to a uniformly charged infinite plane sheet. **(08 Marks)**

b. Find electric field intensity $\overline{E}$ at the origin, if the following charge distributions are present in free space.

i) Point charge of 12 nc at P(2, 0, 6)

ii) Uniform line charge of 3 nc /m at x = 2 and y = 3

iii) Uniform surface charge density 0.4n c/m^2. **(08 Marks)**

c. A point charge of 1.6 nc is located at the origin in free space. Find the potential at r = 0.7 m if – i) the zero reference is at infinity ii) the zero reference is at r = 0.5. **(04 Marks)**

3 a. Given that $\overline{D} = 2xy\overline{a}_x + x^2\overline{a}_y$ c/m^2, evaluate both sides of divergence theorem for the surface defined by $0 \le X \le 1, 0 \le Y \le 2, 0 \le Z \le 3$. **(06 Marks)**

b. With usual notations prove $\nabla.J = \frac{\delta\rho}{\delta t}$, point form of the continuity equation. **(06 Marks)**

c. Using Laplace's equation, derive the expression for potential and electric field distributions for a parallel plate capacitor. Apply proper boundary conditions. **(08 Marks)**

4 a. State and prove Ampere's circuital law and apply it to a infinitely long straight conductor to calculate the magnetic field intensity $\overline{H}$. **(08 Marks)**

b. Given that $\overline{B} = 2.5\sin\left(\frac{\pi X}{z}\right)^{e^{-2y}}\overline{a}_z$ Wb /m^2. Find the total magnetic flux crossing strip $Z = 0, Y \ge 0, 0 \le X \le 2$ m. **(04 Marks)**

c. The magnetic field intensity is given in a region of space as $\overline{H} = \frac{x+2y}{z^2}\overline{a}_y + \frac{2}{z}\overline{a}_z$ A/m.

Find – i) $\nabla \times \overline{H}$ ii) $\overline{J}$ iii) use $\overline{J}$ to find total current passing through the surface $Z = 4, 1 \le X \le 2, 3 \le Y \le 5$, in the $\overline{a}_z$ direction. **(08 Marks)**

5 a. Derive an expression for the force on a differential current element placed in a magnetic field. **(06 Marks)**

b. State and prove the boundary conditions at the interface between two magnetic media of different permeabilities placed in a magnetic field. **(08 Marks)**

c. Derive an equation for energy density in a magnetic field. Determine energy density stored in free space by field $\overline{H} = 10^3\overline{a}_x$ A /m. **(06 Marks)**

6 a. Starting from Faraday's law of electromagnetic induction, obtain Maxwell's equation i integral form and differential form. (08 Marks

b. Write Maxwell's equations in integral form derived from Ampere's law and Gauss's la for good conductor medium and for free space. (05 Marks

c. What is retarded potential? Applying Lorentz condition for potentials obtain expression for retarded potentials V and $\overline{A}$. (07 Marks

7 a. Starting from Maxwell's equations, derive the wave equation for a uniform plane wav traveling in free space. Assume E is in X – direction and H is in Y – direction → and bot vary along Z direction only. (07 Marks)

b. A 400 MHz uniform plane wave propagates through fresh water for which $\sigma = 0$, $\mu_r = 1$ and $\epsilon_r = 80$: calculate – i) attenuation constant ii) phase constant iii) wave length and iv) intrinsic impedance. (06 Marks)

c. With respect to wave propagation in good conductors, describe what the skin effect is and derive an expression for the depth of penetration. If $\sigma = 58 \times 10^6$ ℧ /m at frequency 10 MHz determine depth of penetration. (07 Marks)

8 a. Derive an expression for reflection coefficient and transmission coefficient when a uniform plane wave is incident normally, on the boundary between two different materials. (08 Marks)

b. State and prove Poynting's theorem. (07 Marks)

c. What is a standing wave? Define standing wave ratio. What is its relationship with the reflection coefficient? (05 Marks)