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06ES36

Third Semester B.E. Degree Examination, June/July 2013
Field Theory

Time: 3 hrs. Max. Marks:100

Note: *1. Answer FIVE full questions, selecting at least TWO questions from each part.*
2. Assume any missing data suitably.

PART – A

1 a. State and explain Coulomb's law in vector form. **(05 Marks)**

b. Two point charges $Q_1 = 100\ \mu c$ and $Q_2 = 10\ \mu c$ are located at points (–1, 1, –3)m, (3, 1, 0)m respectively. Find the x, y and z components of the force on Q_1. What is the magnitude of the total force? **(08 Marks)**

c. State and prove Gauss divergence theorem. **(07 Marks)**

2 a. Show that the electric field at any point is given by the negative of the gradient of potential at the point. **(06 Marks)**

b. Find the potential, electric field intensity and volume charge density at a point P(– 4, 3, 6) provided the potential field $V = 2x^2y - 5z$. **(08 Marks)**

c. Discuss the boundary conditions between two perfect dielectrics. **(06 Marks)**

3 a. State uniqueness theorem and prove two solutions V_1 and V_2 are equal using Laplace's equation. **(08 Marks)**

b. Starting with point form of Gauss law, deduce Poisson's & Laplace equations. **(05 Marks)**

c. Given vector $\vec{E} = (12yx^2 - 6z^2x)\hat{a}_x + (4x^3 + 18zy^2)\hat{a}_y + (6y^3 - 6zx^2)\hat{a}_z$. Check whether it represents a possible electric field. **(07 Marks)**

4 a. List the applications of Biot-Savarts law. Explain any one with necessary mathematical representations. **(06 Marks)**

b. Explain the concept of curl with suitable derivation of curl $\vec{F}$. **(06 Marks)**

c. A solenoid of 10 cm diameter and 30 cm length is wound with 150 turns and carries a current of 5 A. Find the magnetic flux density at a point on the axis at a distance of 10 cm from the midpoint of the solenoid. **(08 Marks)**

PART – B

5 a. State and prove the Lorentz force equation. **(08 Marks)**

b. Find the force per meter length between two long parallel wires separated by 10 cm in air and carrying a current of 10 A in the same direction. **(04 Marks)**

c. Consider two different media placed adjacently in a region where there is a magnetic field. Explain with suitable mathematical steps the magnetic boundary conditions. **(08 Marks)**

6 a. Given $\vec{E} = E_m \cdot \sin(\omega t - \beta z)\hat{a}_y$ in free space. Calculate $\vec{D}$, $\vec{B}$ and $\vec{H}$. **(08 Marks)**

b. Do the fields $\vec{E} = E_m \cdot \sin x \cdot \sin t\,\hat{a}_y$ and $\vec{H} = \frac{E_m}{\mu_0} \cdot \cos x \cdot \cos t\,\hat{a}_z$ satisfy the Maxwell's equations? **(08 Marks)**

c. A copper disc 40 cm diameter is rotated at 3000 rpm on a horizontal axis perpendicular to and through the centre of disc axis, lying in magnetic meridian. Two brushes make contact with the disc at diametrically opposite points on the edge. If horizontal component of earth's field is 0.02 mT, find the induced e.m.f between brushes. **(04 Marks)**

7 a. With suitable mathematical steps, prove the relation between $\vec{E}$ and $\vec{H}$ for a travelling uniform plane wave. **(10 Marks)**

b. For silver the conductivity is $\sigma = 3.0 \times 10^4$ s/m. At what frequency will the depth of penetration be 1 mm? **(04 Marks)**

c. State and prove Poynting theorem. **(06 Marks)**

8 a. Explain the reflection of plane waves at the surface of a perfect conductor at normal incidence. **(10 Marks)**

b. What is SWR? With necessary expression, explain in detail SWR. **(10 Marks)**

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