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06EE44

Fourth Semester B.E. Degree Examination, Dec 08 / Jan 09
Field Theory

Time: 3 hrs. Max. Marks:100

Note : ***Answer FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. State and explain Gauss's law. **(06 Marks)**

b. The electric flux density in free space is given by $\hat{D} = y^2z^3\hat{x} + 2xyz^3\hat{y} + 3xy^2z^2\hat{z}$ pc/m^2. Find the total charge contained in an incremental sphere of radius 2 μm centered at A(3, 2, 1)m. **(06 Marks)**

c. Three point charges Q_1= -1 μC, Q_2 = -2μC and Q_3 = -3μC are placed at the corners of an equilateral triangle of side 1 m. Find the magnitude of the electric field intensity at the point bisecting the line joining Q_2 and Q_3. **(08 Marks)**

2 a. State and explain divergence theorem for electric flux density. **(06 Marks)**

b. Derive an expression for the energy expended in moving a point charge in an electric field. **(06 Marks)**

c. The potential field V is given by $V = 2x^2y - 5z$. Calculate the electric field intensity at point P(-4, 3, 6)m. Also calculate the volume charge density that establishes the given potential field. **(08 Marks)**

3 a. Derive an expression relating convection current density, volume charge density and velocity of the charge element. **(06 Marks)**

b. Obtain the boundary conditions at the interface of two dielectrics. **(06 Marks)**

c. Using Laplace's equation, determine the distribution of potential and electric field intensity between two spherical conductors separated by a dielectric. The inner conductor is at potential V_0 while the outer conductor is grounded. **(08 Marks)**

4 a. Use Biot – Savart's law and obtain expression for the field intensity at any point on the axis of a plane circular current loop. **(08 Marks)**

b. State and explain Ampere's circuital law. Also write Ampere's circuital law in point forms. **(06 Marks)**

c. A conductor in the form of a regular polygon of 'n' sides is inscribed in a circle of radius 'r'. Find an expression for the field intensity at the centre of the circle. **(06 Marks)**

PART – B

5 a. A current element 10^{-4} âz Am. is located at (2,0, 0) and another current element $10^{-6}(\hat{x} - 2\hat{y} + 3\hat{z})$ Am. is located at (-2, 0, 0) both in free space. Find the force exerted on each current element by the other current element. **(08 Marks)**

b. An air cored toroid has a c-s area of 6cm^2, a mean radius of 15cm and is wound with 500 turns and carries a current of 4A. Find the magnetic field intensity at the mean radius. **(06 Marks)**

c. Derive differential form of continuity equation from Maxwell's equation. **(06 Marks)**

a. Write Maxwell's equation in point form and in integral form for time varying fields. **(06 Marks)**

b. Starting with Maxwell's equation from Faraday's law, show that the line integral of $\left(\hat{E}+\frac{\partial A}{\partial t}\right)$ around a closed path is zero, where A is magnetic vector potential. **(06 Marks)**

c. What is meant by displacement current? Show that for harmonically varying electric field, the conduction and displacement currents are in time phase quadrature. **(08 Marks)**

a. If the electric field intensity in free space is given by $\hat{E} = E_m \sin \alpha x \sin (wt - \beta z)\ \hat{y}$ V/m, find an expression for the magnetic field intensity $\hat{H}$. **(10 Marks)**

b. In a homogeneous, non conducting region where $\mu_r = 1$, find ϵ_r, ω and V if $\hat{E}$ and $\hat{H}$ fields are given by $\hat{E} = 30\pi e^{j}(wt - \frac{4y}{3})\hat{z}$ V/m and $\hat{H} = 1.0e^{j}(wt - \frac{4}{3}y)\hat{x}$ A/m respectively. **(10 Marks)**

a. Obtain the relation between electric field intensity $\hat{E}$ and magnetic field intensity $\hat{H}$ in a perfect dielectric medium. **(06 Marks)**

b. State and prove Poynting theorem. **(08 Marks)**

c. Define 'depth of penetration'. Show that depth of penetration of a wave in a conductor decreases with an increase in frequency. **(06 Marks)**

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