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10ES36

Third Semester B.E. Degree Examination, June/July 2017

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. Drive the expression for electric field intensity [EFI] due to infinite line charge. **(08 Marks)**

b. A point charge $Q_1 = 25$ nc is located at $P_1(4, -2, 7)$ and a charge $Q_2 = 60$ nc is at $P_2(-3, 4, 2)$, if $\epsilon = \epsilon_0$, find: i) $\overline{E}$ at $P_3(1, 2, 3)$ and (ii) At which point on the 'y' axis is $E_x = 0$? **(06 Marks)**

c. A cube is defined by $1 < x, y, t < 1.2$. If $\overline{D} = 2x^2y\,\overline{ax} + 3x^2y^2\,\overline{ay}$ c/m^2.

i) Apply Gauss's law to find the total flux leaving the closed surface of the cube.

ii) Evaluate $\nabla \cdot \overline{D}$ at the centre of the cube.

iii) Estimate the total charge enclosed within the cube. **(06 Marks)**

2 a. Find the workdone in moving a charge of +2C from (2, 0, 0)m to (0, 2, 0)m along the straight line path joining the two points. If the electric field is $\overline{E} = 2x\,\overline{ax} - 4y\,\overline{ay}$ V/m. **(08 Marks)**

b. Prove that $\overline{E} = -\nabla V$. **(06 Marks)**

c. A potential field in free space is expressed as $V = \frac{20}{xyz}$ volts.

i) Find the total energy shred within the cube $1 < x, y, z < 2$.

ii) What value of the energy would be obtained by assuming a uniform energy density equal to the value at the centre of the cube? **(06 Marks)**

3 a. Let $\epsilon = \epsilon_0$, and $V = 90\,Z^{\frac{4}{3}}$ in the region $z = 0$.

i) Obtain expression for $\overline{E}$, $\overline{D}$ and ρv as function of $\overline{Z}$.

ii) If the velocity of charge density is given as $V_z = 5 \times 10^{-6}\,Z^{\frac{2}{3}}$ m/s. Find I_z at $z = 0$ and $z = 0.1$ m. **(06 Marks)**

b. Derive boundary condition at a boundary between two dielectric medium. **(08 Marks)**

c. Determine whether or not the following potential fields satisfy the Laplace equation:

i) $V = x^2 - y^2 + z^2$ ii) $V = r\cos\phi + z$ **(06 Marks)**

4 a. Find the magnetic field intensity ($\overline{H}$) due to straight conductor of finite length using Biot-Savart law. **(06 Marks)**

b. Using Biot-Savart law, find the value of $\overline{H}$ at that point p for the current circuit shown in Fig.Q4(b).

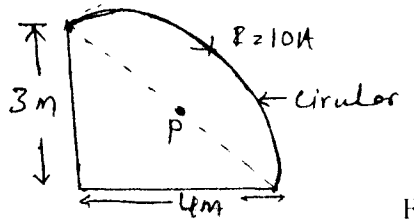

Fig.Q4(b) **(06 Marks)**

c. Define and derive expression for scalar magnetic potential and vector magnetic potential. **(08 Marks)**

PART – B

5 a. Explain force between differential current elements. **(06 Marks)**

b. Explain the magnetic boundary conditions. **(08 Marks)**

c. Define self inductance. Derive expression for the inductance of a co-axial cable. **(06 Marks)**

6 a. Derive Maxwell's equation in vector differential form for time varying field starting from Faraday's law. **(06 Marks)**

b. Derive an expression for general wave equation in free space. **(08 Marks)**

c. An uniform plane of 1 MHz is propagating in medium for which $\sigma = 5.8 \times 10^7$ $\mho$/m and $\epsilon_r = \mu_r = 1$. Find the following:

i) Attenuation constant

ii) Phase shaft constant

iii) Velocity

iv) Wavelength **(06 Marks)**

7 a. State and prove Poynting theorem. **(10 Marks)**

b. The region $Z < 0$ is characterized by $\epsilon'_R = \mu_R = 1$ and $\epsilon''_R = 0$. The total $\bar{E}$ filed here is given as the sum of the two uniform plane waves: $E_S = 150e^{-j10z}\overline{ax} + (50\angle 20)e^{j10z}ax$ V/m.

Find:

i) What is the operating frequency?

ii) Specify the intrinsic impendence of the region $Z > 0$ that would provide the appropriate reflected wave.

iii) At what value of $Z(-10cm < z < 0)$ is the total electric field intensity a maximum amplitude? **(10 Marks)**

8 a. Define SWR and derive the expression for SWR in term of reflection coefficient. **(10 Marks)**

b. Explain reflection of uniform plane waves at normal incidence, derive the expressions for transmission and reflection coefficient. **(10 Marks)**

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