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(3 Hours)

[Total Marks : 100

Electromagnetic Engineering

N.B.: (1) Question No. 1 is compulsory.

(2) Attempt any four questions from rest of questions.

(3) Use of Smith Chart is allowed.

(4) Assume insufficient data if any.

2-30 to 5-30 pt

1. (a) Two point charges $-4\mu\text{C}$ and $5\mu\text{C}$ are located at $(2, -1, 3)$ and $(0, 4, -2)$ respectively. Find the potential at $(1, 0, 1)$ assuming zero potential at infinite. 5

(b) Derive wave equation for free space starting from Maxwell's equation. 5

(c) A 30 m long lossless transmission line with $Z_0 = 50 \Omega$ operating at 2 MHz is terminated with load $Z_L = 60 + j 40 \Omega$. If $u = 0.6$ C on the line, find— 5

(i) The reflection coefficient and

(ii) The standing wave ratio.

(d) Prove that $\Delta \times H = D + J$. 5

2. (a) If $\vec{E} = -8xy \vec{a}_x + 4x^2 \vec{a}_y + \vec{a}_z$ V/m. 8

Find the work done in carrying 6 coulombs of charge from A(1, 8, 5) to B(2, 18, 6) along the path $y = 3x + 2$, $z = x + 4$.

(b) In a medium characterised by $\sigma = 0$, $\mu = \mu_0$, ϵ_0 and 12

$$\vec{E} = 20 \sin(10^8 t - \beta z) \vec{a}_y \text{ V/m}$$

Calculate β and H.

3. (a) What is impedance matching? Explain various methods of impedance matching in transmission lines. 8

(b) Explain various types of electromagnetic interference. What are various sources of EMI. Explain in brief? 12

4. (a) An antenna with impedance $40 + j 30 \Omega$ is to be matched to a 100Ω lossless line with a shorted stub. Determine : 10

(i) The required stub admittance

(ii) The distance between stub and antenna.

(iii) The stub length

(iv) The standing wave ratio on each section of the system.

(b) A lossy dielectric has an intrinsic impedance of $200 \angle 30^\circ \Omega$ at a particular frequency. If at that frequency plane wave propagating through the dielectric has the magnetic field component. 10

$$\vec{H} = 10e^{-\alpha x} \cos\left(\omega t - \frac{1}{2}x\right) \vec{a}_y \text{ A/m}$$

Find \vec{E} and α . Determine the skin depth and wave polarisation.

5. (a) Prove that the flux of sum $(\mathbf{J} + \frac{\partial \mathbf{D}}{\partial t})$ through any closed surface is zero. 10
- (b) Find magnetic vector potential and magnetic field at a point due to current I in a long straight conductor of rectangular cross section $(2a \times 2b)$. 10
6. (a) Determine the reflection coefficients for an electromagnetic wave incident normally on (i) a sheet of copper (ii) a sheet of iron. Use $f = 1$ MHz. 10
Assume $\sigma = 1 \times 10^6$ Ω^{-1}/m $\mu = 1000 \mu_0$ for the iron.
- (b) A straight long uniform wire carries a steady current I . If the potential difference across a length l is V , find the value of the Poynting vector at a distance r from the wire. Hence, show that the energy flowing into the wire is VI per unit time. 10
7. (a) Derive Radiation Potential function for sinusoidal function. 10
- (b) For a distributed element transmission line derive the relation for characteristic impedance and propagation constant. 10
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