ii. A lossy material has $\mu = 5\mu_o$, $\varepsilon = 2\,\varepsilon_o$. If at 5 MHz, the phase constant is 10 rad/m, calculate **5**
(a) The loss tangent
(b) The conductivity of the material
(c) The complex permittivity
(d) The attenuation constant
(e) The intrinsic impedance

iii. Derive voltage and current equation of transmission line in terms of secondary constants. **5**

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Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No.....

Faculty of Engineering
End Sem Examination May-2023
EC3CO08 Engineering Electromagnetics

Programme: B.Tech. Branch/Specialisation: EC

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. Spherical systems have the following metric co-efficient- **1**
(a) 1, r ,1 (b) 1, r, cosθ (c) 0, r , r sinθ (d) 1, r, r sinθ

ii. $\nabla.(\nabla\, X\, \vec{A})$ is equal to- **1**
(a) $\nabla.\vec{A}$ (b) $\nabla\, X\, \vec{A}$ (c) $\nabla^2\, \vec{A}$ (d) 0

iii. A sheet of charge lies in yz plane at x=0 and has uniform surface charge density of 5pC/m^2.Find the electric field at a point P(-5,0,0) on x-axis. **1**
(a) -0.283 a_x (b) 0.283 a_z (c) 0.712 a_y (d) -0.712 a_y

iv. Gauss law related the electric field intensity E with the volume charge density ρ at a point as- **1**
(a) $\nabla \times E = \varepsilon\rho$ (b) $\nabla.E = \varepsilon\rho$
(c) $\nabla \times E = \rho/\varepsilon$ (d) $\nabla.E = \rho/\varepsilon$.

v. The magnetic vector potential A does not obey the equation **1**
(a) $B = \nabla \times A$, (b) $H = -\nabla A$
(c) $\nabla^2 A = -\mu_0 J$ (d) $A = \int \frac{\mu_0\, I\, dl\, Ide}{4\pi R}$

vi. For a conservative field which of the following equations holds good? **1**
(a) $\int E.dl = 0$ (b) $\int H.dl = 0$
(c) $\int B.dl = 0$ (d) $\int D.dl = 0$

vii. When the conduction current density and displacement current density are same, the dissipation factor will be **1**
(a) Zero (b) Minimum (c) Maximum (d) Unity

P.T.O.

viii. E and H are related as- **1**

(a) $\frac{E}{H} = \sqrt{\mu\,\varepsilon}$ (b) $\frac{H}{E} = \sqrt{\mu\,\varepsilon}$

(c) $\frac{H}{E} = \sqrt{\frac{\mu}{\varepsilon}}$ (d) $\frac{E}{H} = \sqrt{\frac{\mu}{\varepsilon}}$

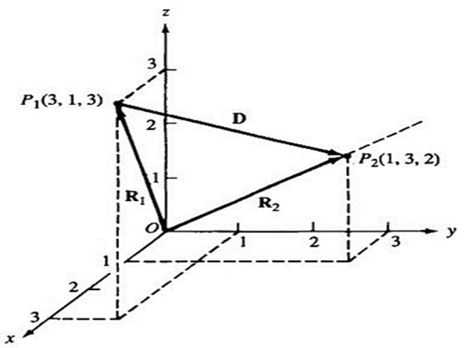
ix. Find the reflection coefficient of a wave with an incident electric field of 5 V/m and reflected electric field of 2 V/m. **1**

(a) 2.5 (b) 0.4 (c) 0.8 (d) 1.2

x. For a critical angle of 60 degree and the refractive index of the first medium is 1.732, the refractive index of the second medium is- **1**

(a) 1 (b) 1.5 (c) 1.66 (d) 2

Q.2 i. Find the mathematical expression of vector R1, R2 & D. **2**



ii. Convert the vector field E = 2cosθ a_r + sinθ a_θ into Cartesian coordinate system. **3**

iii. Given a vector field $\vec{F} = \frac{\cos\theta}{r^2}\hat{a}_r + \frac{\sin\theta}{r}\hat{a}_\theta$, express $\vec{F}$ in the rectangular coordinate system. **5**

OR iv. Explain Stoke's theorem. prove that- **5**

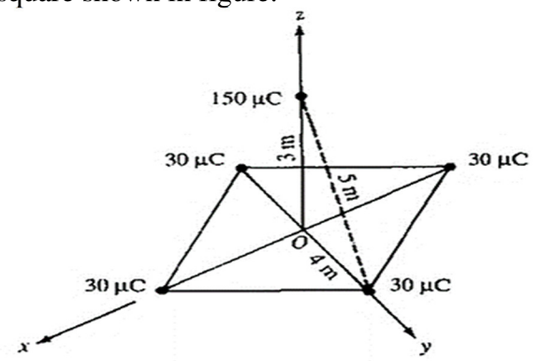
$$\int_s (\nabla \times \vec{A}).ds = \oint_c \vec{A}.dl$$

Q.3 Attempt any two:

i. Define Electric flux density. Write statement and derive relationship of Gauss's Law. **5**

ii. Derive the electric field E due to the infinite line charge at point P in the XY-plane, line located in the z-axis with charge density ρ_l (C/m). **5**

iii. Four like charges of 30 μC Each are located at four corners of squares, find the force on a 150 μC charge located 3m above the center of the square shown in figure. **5**



Q.4 Attempt any two:

i. Derive expressions for energy stored and energy density in magnetic field. **5**

ii. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of 6cm diameter. The length of the tube is 60cm and the solenoid is air. **5**

iii. Derive magnetic boundary conditions for normal and tangential component. **5**

Q.5 i. What is the difference between conduction current and displacement current? **2**

ii. Find the skin depth at a frequency of 20 MHz in aluminium where σ = 38.2x10^6 mho / m and μ_r=1. **3**

iii. Discuss about Lorentz force equation. **5**

OR iv. State and prove Poynting Theorem. Show that field varying sinusoidally in time, the time average pointing vector is given **5**

$$\langle \vec{P} \rangle = \frac{1}{2}\mathrm{Re}\left[\vec{E} \times \vec{H}\right]$$

Q.6 Attempt any two:

i. Define the following (write necessary mathematics for each case): **5**

(a) Linear polarization (b) Circular polarization

(c) Elliptical polarization (d) Axial Ratio

Marking Scheme

EC3CO08[T] Engineering Electromagnetics

Q.1 i) Spherical systems have the following **metric co-efficient** **1**

d) 1, r, r sinθ

ii) $\nabla.(\nabla X \vec{A})$ is equal to **1**

d) 0

iii) A sheet of charge lies in yz plane at x=0 and has uniform surface charge density of 5pC/m^2.Find the electric field at a point P(-5,0,0) on x-axis. **1**

a) -0.283 a_x

iv) Gauss law related the electric field intensity **E** with the volume charge density ρ at a point as **1**

(d) $\nabla.\boldsymbol{E} = \rho/\varepsilon.$

v) The magnetic vector potential A does not obey the equation **1**

(b) $\mathbf{H} = -\nabla\mathbf{A}$

vi) For a conservative field which of the following equations holds good? **1**

$a)\ \int E.dl = 0$

vii) When the conduction current density and displacement current density are same, the dissipation factor will be **1**

d) Unity

viii) E and H are related as **1**

(d) $\frac{E}{H} = \sqrt{\frac{\mu}{\varepsilon}}$

ix) Find the reflection coefficient of a wave with an incident electric field of 5 V/m and reflected electric field of 2 V/m. **1**

b) 0.4

x) For a critical angle of 60 degree and the refractive index of the first medium is 1.732, the refractive index of the second medium **1**

is

b) 1.5

i. Find the mathematical expression of vector **2**

Expression of **R1**,**R2** **(1)**

Expression of **D** **(1)**

ii. Convert the vector field **E** = 2cosθ $\mathbf{a_r}$ + sinθ $\mathbf{a_\theta}$ into Cartesian coordinate system. **Step marking** **3**

iii. Given a vector field $\overline{F} = \frac{\cos\theta}{r^2}\hat{a}_r + \frac{\sin\theta}{r}\hat{a}_\theta$, express $\overline{F}$ in the rectangular coordinate system. **Step marking** **5**

OR iv. Explain Stoke's theorem. (2) **5**

prove that

$$\int (\nabla \times \vec{A}).ds = \oint \vec{A}.dl$$

s c (3)

Q.3 i. Define Electric flux density. (2) **5**

Write statement (1)

and derive relationship of Gauss's Law. (2)

ii. Derive the electric field E due to the infinite line charge at point P in the XY-plane, line located in the z-axis with charge density ρ_l (C/m). **step marking** **5**

OR iii. Four like charges of 30 μC Each are located at four corners of squares ,find the force on a 150 μC charge located 3m above the center of the square shown in the fig.03 **step marking** **5**

Q.4 i. Derive expressions for energy stored --- (2.5) **5**

and energy density in magnetic field. ----- (2.5)

ii. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of 6cm diameter .The length of the tube is 60cm and the solenoid is air. **5**

step marking

OR iii. Derive magnetic boundary conditions for normal (2.5) **5**
and

Derive magnetic boundary conditions tangential (2.5)

Q.5 i. What is the difference between conduction current and displacement current? **2**

Any two differences

ii. Find the skin depth at a frequency of 20 MHz in aluminium where $\sigma = 38.2x10^6$ mho / m and $\mu_r=1$. **3**

iii. Derive the Helmholtz wave equation in source free region. **5**

step marking

OR iv. State and prove Poynting Theorem. (2) **5**

Show that field varying sinusoidally in time, the time average pointing vector is given

$$\langle \vec{P} \rangle = \frac{1}{2}\mathrm{Re}\left[\vec{E}\times\vec{H}\right]$$

(3)

Q.6 Attempt any two:

i. Define the following (write necessary mathematics for each case) **5**

(a) Linear Polarization (1)

(b) Circular polarization (1)

(c) Elliptical Polarization (1)

(d) Axial Ratio (2)

ii. A lossy material has $\mu = 5\mu_o$, $\varepsilon = 2\,\varepsilon_o$. If at 5 MHz, the phase constant is 10 rad/m, calculate **5**

(a) The loss tangent (1)

(b) The conductivity of the material (1)

(c) The complex permittivity (1)

(d) The attenuation constant (1)

(e) The intrinsic impedance (1)

OR iii. Derive voltage equation (2.5) **5**

Derive current equation (2.5)

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