

ELECTROMAGNETIC THEORY & TRANSMISSION LINES

(Electronics and Communication Engineering)

Time: 3 hours

Max. Marks: 70

PART – A
(Compulsory Question)

- 1 Answer the following: (10 X 02 = 20 Marks)
- Express unit vectors of cylindrical coordinates in terms of unit vectors of rectangular coordinates with help of suitable diagram.
 - Given the potential field, $V = 2x^2y - 5z$, find the electric field intensity \vec{E} at point $P(-4, 3, 6)$.
 - State and explain Biot-Savart's law.
 - There are two current loops placed apart and are carrying I_1 & I_2 respectively. Give the expression for magnetic force on current loop 1 due to current loop 2.
 - A parallel – plate capacitor with plate area of 5 cm^2 and plate separation of 5 mm has a voltage $36\pi \sin 1000t \text{ V}$ applied to its plates. Calculate the displacement current assuming $\epsilon_r = 2$ of the medium between the plates.
 - State the two boundary conditions for the magnetic fields at the interface of two different media.
 - Let us consider two perfect dielectric media 1 & 2 with their intrinsic impedances $\eta_1 = 100 \Omega$ & $\eta_2 = 300 \Omega$ respectively. If the maximum amplitude of incident electric field intensity (in medium 1) $E_1^+ = 100 \text{ V/m}$, determine amplitude of the transmitted electric field intensity E_2^+ .
 - What is skin depth? Give the expression for skin depth in case of good conductors.
 - Define: (i) A losses line. (ii) A distortionless line.
 - A certain microstrip line has fused quartz ($\epsilon_r = 3.8$) as a substrate. If the ratio of line width to substrate thickness is $\frac{w}{h} = 4.5$, determine effective relative permittivity of the substrate.

PART – B

(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

- 2 (a) Derive the expression for Electric field intensity (\vec{E}) at any point due to finite length line charge with suitable sketches.
- (b) A plane at $y = -5$ carries a surface charge of 15 nC/m^2 . If a line $x = 0, z = 2$ carries charge $10\pi \text{ nC/m}$, calculate the electric flux density (\vec{D}) at $(1, 1, 1)$ due to the charge distributions. Assume free space.

OR

- 3 (a) Obtain the expression for electric field intensity \vec{E} at a far point due to a dipole located at the origin.
- (b) Given the potential field $V = 50\sin\theta/r^2 \text{ V}$ in free space, determine whether potential V satisfies Laplace's equation or not. Justify the statement.

UNIT – II

- 4 (a) State Ampere's circuital law. Apply this law to determine magnetic field intensity \vec{H} at any point in free space due to (i) An infinite line current. (ii) An infinite current sheet.
- (b) A straight solid wire segment carrying a current $2 \hat{a}_y \text{ A}$ extends from a point $(0, 1, 2)$ to another point $(0, 4, 2)$ in free space. This wire is subjected to the magnetic field of an infinite current filament lying along the z – axis and carrying 25 A in the \hat{a}_z direction. Find the vector torque on the wire segment about an origin at a point $(0, 0, 2)$.

OR

- 5 (a) Establish the relationship between magnetic energy and the magnetic field intensity.
- (b) One infinite current filament of 10 A lies on y -axis along \hat{a}_y & another infinite current filament of 20 A lies on z -axis along $-\hat{a}_z$. Find the magnetic field intensity \vec{H} at $(-3, 4, 5)$.

Contd. in page 2

UNIT – III

6 Derive all the Maxwell's equations for time varying fields from the fundamental principles of electromagnetic fields.

OR

- 7 (a) Express the Maxwell's equations in phasor form and give their word statements.
 (b) The region $z < 0$ contains a perfect dielectric for which $\epsilon_{r_1} = 2.5$, while the region $z > 0$ is characterized by $\epsilon_{r_2} = 4$. If $\vec{E}_1 = -30\hat{a}_x + 50\hat{a}_y + 70\hat{a}_z$ V/m, find the electric flux density in the region 2.

UNIT – IV

- 8 (a) Derive the Helmholtz's equation using electric field intensity for lossy dielectrics from the Maxwell's equations & solve the same in rectangular coordinates to obtain the expression for electric field intensity.
 (b) In nonmagnetic medium $\vec{E} = 4 \sin(2\pi \times 10^7 t - 0.8x)\hat{a}_z$ V/m. Find the time averaged power carried by the wave.

OR

- 9 (a) State and prove the Poynting theorem. Give its word statement.
 (b) For a copper coaxial cable, let $a = 2$ mm, $b = 6$ mm and thickness $t = 1$ mm. Calculate the resistance of 2 m length of the cable at 100 MHz. Assume that the conductivity of copper material is 5.8×10^7 mho/m.

UNIT – V

- 10 (a) Derive the expression for input impedance of a transmission line when it is terminated by a load.
 (b) A distortionless line has $Z_0 = 60 \Omega$, attenuation constant $\alpha = 20$ mNp/m, signal velocity $u = 1.8 \times 10^8$ m/s. Find the primary parameters of the transmission line at 100 MHz.

OR

- 11 (a) Explain the importance of Smith chart with all its details.
 (b) A 30 ohm lossless transmission line has $Z_0 = 50 \Omega$ operating at 2 MHz is terminated with a load $Z_L = 60 + j40 \Omega$. If the signal velocity on the line is 60% of velocity of light, then find the reflection coefficient and input impedance.

UPIQP.BANK.COM