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**Paper Code : EC-401**

## ELECTROMAGNETIC THEORY & TRANSMISSION LINES

*Time Allotted* : 3 Hours | *Full Marks* : 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

### GROUP – A

### ( Multiple Choice Type Questions )

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) Divergence of vector is always

   a) Vector b) Scalar

   c) Can be both d) none of these.

   ii) At high frequencies, the characteristic impedance of a transmission line is given as

   a) $\sqrt{R/G}$ b) $\sqrt{G/R}$

   c) $\sqrt{L/C}$ d) $\sqrt{C/L}$.









iii) The rate of energy flow is given by

a) Maxwell equation

b) Poynting vector

c) Poisson equation

d) Equation of continuity.

iv) Which of the following is zero ?

a) Grad div b) Curl grad

c) Div grad d) Curl curl.

v) The maximum impedance on a lossless transmission line of characteristic impedance 50 ohm and VSWR 2.5 will be

a) 125 ohm b) 20 ohm

c) 75 ohm d) 100 ohm.

vi) The unit of magnetic vector potential is

a) volt/m b) weber/m

c) coulomb/m d) newton/m.

vii) The wavelength of a wave with a propagation constant = $0.1\pi = j0.2\pi$ is

a) 10 m b) 20 m

c) 30 m d) 25 m.

viii) If the reflection coefficient of a transmission line is $0.5 + j0.5$ for a given load, VSWR is

a) 1 b) 20

c) 2 d) $\infty$.

ix) In a transmission line, the distance between adjacent maxima and minima of a standing wave is

a) $\lambda/8$ b) $\lambda/4$

c) $\lambda/2$ d) $\lambda$.

x) A load impedance of 100 Ω is connected to a 50 Ω line. VSWR of unity is obtained by connecting

a) another 50 Ω in series with $Z_L$

b) another 50 Ω in parallel with $Z_L$

c) another 100 Ω in series with $Z_L$

d) another 100 Ω in parallel with $Z_L$.

xi) A transmission line is called distortionless if

a) $R/L = G/C$ b) $R/G = C/L$

c) $RG = L/C$ d) $R/G = LC$.









xii) A transmission line is terminated by a pure capacitor. The VSWR in the line is

a) 1

b) 0

c) depends on the value of capacitor

d) $\infty$.

xiii) A transmission line is characteristic impedance 55 Ω is terminated in a load of 55 Ω. Its input impedance is

a) 75 Ω b) 55 Ω

c) 300 Ω d) 110 Ω.

xiv) Which of the following is not true for a dielectric to dielectric interface ?

a) $B_{n1} = B_{n2}$ b) $E_{t1} = E_{t2}$

c) $D_{n1} = D_{n2}$ d) $H_{t1} - H_{t2} = J_s$.

xv) Displacement current density is

a) time rate of change of electric flux density

b) time rate of change of magnetic flux density

c) time rate of change of potential

d) time rate of change of magnetic potential.

## GROUP – B
### ( Short Answer Type Questions )

Answer any *three* of the following. 3 × 5 = 15

2. a) Define propagation constant of a transmission line.

   b) A distortionless transmission line has a characteristic impedance of 50 ohm and a phase constant of 3 rad/m at 10 MHz. Find the inductance and the capacitance of this line. 2 + 3

3. Deduce Friis transmission equation.

4. Prove that the Electric Field Intensity (E) is negative gradient of potential (V).

5. Find the location of the point ( 2, – 1, 3 ) in spherical co-ordinate.

6. Derive Poisson's & Laplace's equations.

## GROUP – C
### ( Long Answer Type Questions )

Answer any *three* of the following. 3 × 15 = 45

7. a) What is Biot-Savart's law is magnetostatics ?

   b) If an infinitely extended wire of negligible cross-section is placed along $x$-axis and carrying current I, find the magnetic field intensity at a point $P(x, y, z)$ at a distancer from the wire.

   c) Starting from Ampere's circuit law derive the relation $\vec{\nabla} \times \vec{H} = \vec{J} \times \frac{\overrightarrow{\partial D}}{\partial t}$, where symbols have their usual meanings. 3 + 7 + 5









8. a) Prove that the electromagnetic power (P) passing through free space is given by the expression $\vec{P} = \vec{E} \times \vec{H}\ W/m^2$.

   b) Derive the expressions of the electric and magnetic fields of an EM wave propagation in a lossy dielectric medium.

   c) What are magnetic vector potential and retarded magnetic vector potential ? 6 + 6 + 3

9. a) Derive an expression for the input impedance $Z_m$ of a transmission line, in terms of relevant parameters, when the line is terminated by impedance $Z_L$.

   b) Explain the quarter-wave transformer technique of matching.

   c) A lossless, half wavelength line has $Z_0 = 50$ ohm. It is terminated by load resistance of 100 ohm. Determine

      i) Reflection coefficient

      ii) VSWR

      iii) $Z_{min}$

      iv) $Z_{max}$. 5 + 5 + 5

10. a) Define radiation resistance of a folded dipole antenna. Why is it beneficial for our TV reception antenna ?

    b) What are half power beam width ( HPBW ) and beam width between flint nulls ( BWFN ) ?

    c) A magnetic field strength of 5 $\mu A/m$ is required at a point on $\theta = \lambda/2$, 2 km from an antenna in air. Neglecting the ohmic loss how much power must the antenna transmit if it is a Hertzian dipole of length $\lambda/25$ ?

    d) Write the applications of loop antenna. 4 + 5 + 4 + 2

11. Write short notes on any *three* of the following : $3 \times 5 = 15$

    a) Single stub matching

    b) Solenoidal and conservative fields

    c) Distortionless transmission line

    d) Half wave dipole antennas

    e) Skin effect.