This question paper contains 4 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **8765**

Unique Paper Code : **251506** **C**

Name of the Paper : **ELHT-504 : Wave Propagation and Antenna**

Name of the Course : **B.Sc. (H) Electronics Part III**

Sémester : **V**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. **1** is compulsory.

Attempt *Five* questions in all.

All questions carry equal marks.

1. Attempt any *five* :

   (*a*) A two-conductor transmission line supports TEM wave. Explain.

   (*b*) Find the skin depth at a frequency of 1.6 MHz in aluminum where $\sigma = 38.2 \times 10^7$ mhos/m and $\mu_r = 1$.

   (*c*) What is an antenna array ? What specific properties does it have that make it so useful at high frequencies ?

   (*d*) Explain the difference between TE_{mn} and TM_{mn} modes.

   (*e*) The electric field in free space is given by $E = 50 \cos (10^8 t + \beta x) a_y$ V/m

   (*i*) Find the direction of wave propagation.

   (*ii*) Calculate β and the time it takes to travel distance of $\lambda/2$.

   (*f*) How is a cavity resonator different from a conventional LC circuit ? 3×5

P.T.O.

2. (*a*) A transmission line of length l characterized by γ (propagation constant) and Z_O (characteristics impedance) is connected to a load Z_L. Determine the voltage reflection coefficient and power flow on this line. Also, find the standing wave ratio (SWR) on the shorted line (Z_L = O) and matched line ($Z_L = Z_O$).

(*b*) A distortionless line has characteristic impedance (Z_O = 60 Ω), attenuation constant (α = 20 m Np/m) and wave velocity ($u = 0.6c$, where c is the speed of light in vacuum). Find resistance per unit length (R), inductance per unit length (L), conductance per unit length (G), capacitance per unit length (C) and wavelength (λ) at 100 MHz. 10,5

3. (*a*) Obtain the wave equations for electric and magnetic field vectors (**E** and **H**) in a homogeneous, isotropic dielectric medium having permittivity (ε) and permeability (μ). Hence show that the electromagnetic waves travel with a speed less than speed of light. Also, find out the intrinsic impedance offered by medium to wave. And show that electric and magnetic field vectors are in phase with each other.

(*b*) A plane wave of frequency 2 MHz is incident normally upon a copper conductor. The wave has an electric field amplitude of E = 2 mV/m. Find the average power density absorbed by copper (μ_r = 1, ε_r = 1 and $\sigma = 5.8 \times 10^7$ mho/m). 12,3

4. (*a*) Obtain Fresnel's equations for the reflection and transmission of a plane electromagnetic wave incident obliquely at the interface of two dielectric media when electric field vector (**E**) of incident wave is parallel to plane of incidence.

(*b*) What is Brewster's angle ? Show that there is a Brewster's angle for any combination of ε_1 and ε_2.

(*c*) A standard air-filled rectangular wave guide with dimensions a = 8.636 cm and b = 4.318 cm is fed by 4 GHz carrier from a coaxial cable. Determine whether a TE_{10} mode will be propagated. If so, calculate the phase velocity and group velocity. 7,4,4

5. (*a*) Explain the term retarded potential and use this concept to derive far-field expressions for electric and magnetic fields for a Hertzian dipole. Also find its radiation resistance.

(*b*) A magnetic field strength of 5 μA/m is required at a point on $\theta = \pi/2$, 2 km from an antenna in air. Neglecting ohmic losses, how much power must the antenna transmit if it is a Hertzian dipole of length $\lambda/25$. 10,5

6. (*a*) Discuss how a $\lambda/4$ line acts as an impedance transformer. What is its main disadvantage?

(*b*) Differentiate between lossless and distortionless transmission line.

(*c*) In a non-magnetic medium $\mathbf{E} = 4 \sin (2\pi \times 10^7 \ t - 0.8 \ x) \ a_z$ V/m.

Find :

(*i*) ε_r (relative permittivity), η (intrinsic impedance)

(*ii*) The time-average power carried by the wave.

(*iii*) The total power crossing 100 cm^2 of plane $2x + y = 5$ 5,4,6

P.T.O.

7. (*a*) Explain why rectangular wave guide cannot support TEM mode.

(*b*) Derive radar range equation for a mono-static radar. Give the range of radar transmission frequencies.

(*c*) Show that plane electromagnetic wave obeys the laws of reflection and transmission at the interface of two dielectric media. 3,8,4

Physical Constants :

$\mu_0 = 4\pi \times 10^{-7}$ H/m

$\varepsilon_0 = 8.854 \times 10^{-12}$ F/m

$c = 3 \times 10^8$ m/s .