PHYSICS Paper-B

(Vibrations, Waves and E.M. Theory-II)

Time Allowed : Three Hours **Maximum Marks : 44**

Note: (i) Attempt **five** questions in all, selecting two questions from each of section A and section B.

(ii) Section C is compulsory.

(iii) The use of non-programmable calculator is allowed.

(iv) Logarithmic tables may be asked if needed.

(v) After evaluation of answer books out of 44 marks, the marks will be given out of 22.

Section – A

1. (a) Derive expression for reflection and transmission coefficient at the boundary between two media. What will be their values when impedance of transmitted section is :

(i) Zero (ii) Infinity? 5

(b) Two strings of linear densities 0.5g/cm and 1.5 g/cm join together and stretched by certain force. Calculate :

(i) Ratio of wave speed in the two strings.

(ii)Reflection and transmission coefficient of energy. 4

2. (a) What do you mean by characteristic impedance of the string? Show that it is given by product of mass per unit length of string and wave velocity. 5

(b) Prove that intensity of a progressive wave is proportional to square of amplitude. 4

3. (a) Obtain expression for energy of vibrating string. 5

(b) Define the term wave velocity and group velocity. Find the relation between wave velocity and group velocity. Is group velocity always greater than wave velocity ? Comment. 4

Section – B

4. (a) Using Maxwell equations, derive the wave equation of e.m. waves in the medium having finite permeability and permittivity but no conductivity ($\sigma = 0$). 5

(b) Calculate the amplitudes of electric and magnetic field vector at the surface of earth. Assuming the solar radiations reaches the earth as plane wave and average power received by earth is 1.24×10^3 Wm^{-2}. 3

(c) Define skin depth. 1

5. (a) What is the Poynting vector ? State and prove Poynting theorem. 5

(b) Derive the expression for impedance of conducting medium to the e.m. waves and hence show that phase difference between electric field and magnetic field of e.m. wave in the conductor is $\pi/4$. 4

6. (a) Discuss propagation of plane e.m. waves incident normally at the boundary separating two media of different impedances and show that a perfect conductor is a perfect reflector of e.m. waves. 5

(b) Show that in the conducting medium, the displacement current leads the conduction current by $\pi/2$ radian. 2

(c) A plane radio wave has $E_0 = 10^{-4}\ Vm^{-1}$. Calculate :

(i) B_0 and (ii) Intensity S_{av} of the wave. 2

Section – C

7. Attempt any **eight** parts :

(a) The sinusoidal wave is $y = 0.1 \sin 2\pi (0.01x - 100t)$ where x, y are in meter and t in second. Calculate the speed of the wave.

(b) Show that $y = x^2 + c^2t^2$ the solution of one dimensional wave equation.

(c) Can a sinusoidal wave be used for transmission of a signal ? Explain.

(d) Give the examples of normal and anomalous disperssion mediums.

(e) What are the nodes and antinodes in stationary waves?

(f) If the first medium is air and second medium has refractive index 2. Calculate the reflection and transmission coefficient of energy.

(g) What is the value of impedance of dielectric to e.m. waves in vacuum?

(h) Write down the dimension of $\vec{E} \times \vec{H}$.

(i) High frequency e.m. waves propagate only small distance in a conductor. Comment.

(j) What is the impedance matching ? Give its applications. $8 \times 1 = 8$