Exam. Code : 103202
Subject Code : 1338

B.A./B.Sc. 2nd Semester

PHYSICS PAPER–B (Vibrations and Waves)

Time Allowed—3 Hours] [Maximum Marks—35

Note :– The question paper has **five** Sections. Attempt all questions in Section A and **one** question each from Sections B, C, D and E.

SECTION–A

1. (a) A mass of 1 kg is attached to a spring of stiffness constant 16 N/m. Find its natural frequency.

   (b) Define logarithmic decrement for mechanical oscillator.

   (c) What is the phase relationship between displacement and acceleration in S.H.M ?

   (d) What is the relation between band width and Q-factor for a forced oscillator ?

   (e) What is the value of coupling coefficient for tight and loose coupling ?

   (f) Two sinusoidal waves represented by $y(1) = 0.06 \cos (8t - 11x)$ and $y(2) = 0.06 \cos (6t - 9x)$ were superimposed. Calculate the group velocity.

   (g) What is mechanical impedance of a forced oscillator ? What is its unit ? $1 \times 7 = 7$

SECTION–B

2. (a) A particle is subjected simultaneously to two SHM of the same period but of different amplitudes and phases in perpendicular direction. Find the expression for the resultant motion. For what condition the path may be straight line, ellipse/circle ? 5

(b) A particle is executing SHM with amplitude A. At what displacement from mean position the kinetic energy is equal to potential energy in SHM ? 2

3. (a) What is electrical oscillator ? What oscillates in Simple Harmonic Electrical Oscillator (SHE) ? Set up the differential equation for SHE oscillator. Find the charge on capacitor plates as a function of time. 5

(b) The potential energy of 1 kg mass executing SHM is $(2x^2 + 4x + 4)\ddot{j}$. What are the values of the force constant and frequency of oscillator ? 2

SECTION–C

4. (a) What are damped vibrations ? Derive the differential equation for damped SH system. What are the different solutions ? Discuss the case of oscillatory damped SH system. 5

(b) Show that Q-factor represents the change in phase during which the energy of damped oscillations reduces to $\frac{1}{e}$ of initial value. 2

5. (a) Prove that damping force is independent of acceleration and depends upon velocity only. 4

(b) Define relaxation time of damped oscillator. Show that it varies inversely as the damping constant. 3

SECTION–D

6. What are the normal modes of vibration ? Find solution for normal modes. Show that the displacement of two pendulums are superposition of normal modes. Also show that there is no exchange of energy between normal modes. 7

7. What is forced oscillator ? Derive an expression for velocity of a forced oscillator. Discuss variation of velocity amplitude with driving force frequency. Show that the resonant frequency of driving force is less than the natural frequency of displacement. 7

SECTION–E

8. (a) Show that the wave equation in case of tranverse wave on a string is given by $\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y}{\partial t}$, where $v = \sqrt{\frac{T}{\mu}}$, T being tension on the string and μ is the linear density of the string. 5

(b) Distinguish between wave velocity and group velocity of waves. How they are related to each other ? 2

9. (a) Discuss how transverse waves are reflected and transmitted at a boundary. Find the reflection and transmission coefficient. 5

(b) What are stationary waves ? What do you mean by nodes and antinodes in a stationary wave ? 2