

**3 (Sem-1) PHY M 2**

**2 0 1 8**

**PHYSICS**

**( Major )**

**Paper : 1.2**

*Full Marks : 60*

*Time : 3 hours*

*The figures in the margin indicate full marks  
for the questions*

**SECTION—I**

**( Waves and Oscillations )**

**( Marks : 40 )**

1. (a) What is the phase difference between the displacement and acceleration of a particle executing SHM? 1
- (b) A wave  $y = a \sin(\omega t - kx)$  on a string meets with another wave producing a node at  $x = 0$ . Write the wave equation of the unknown wave. 1
- (c) What is reverberation of sound? 1
- (d) The function  $f(x) = x^2$  is defined within the interval  $-\pi \leq x \leq \pi$  and outside it is periodic. State whether the function is even or odd within  $-\pi \leq x \leq \pi$ . 1

2. (a) What is sharpness of resonance? Explain the effect of damping on the sharpness of resonance. 2
- (b) The phase velocity  $V$  depends on the wavelength  $\lambda$  according to relation  $V = A\sqrt{\lambda}$ , where  $A$  is constant. Show that group velocity is half of the phase velocity. 2
- (c) If the displacement  $x$  and velocity  $V$  of a particle executing simple harmonic motion are related through the expression  $4V^2 = 25 - x^2$ , then calculate its time period. 2

3. Answer any *two* questions : 5×2=10

- (a) Show that in case of damped oscillation the loss of energy is equal to the rate of work done against the resistive force.
- (b) A particle is simultaneously subjected to two simple harmonic motions moving in the same direction, each of same frequency but of different amplitude. If phase difference between them is  $\pi/4$ , find the amplitude of the resultant motion and the phase relation to one of the components.
- (c) Derive the expression for the velocity of transverse wave propagating in a stretched string under tension.

Answer any two questions :

4. Find the Fourier series for a function

$$f(x) = 0, \text{ for } -\pi < x < 0 \\ = h, \text{ for } 0 < x < \pi$$

What are the conditions for a function which can be expanded by Fourier series? 7+3=10

5. What are beats? Give an analytical description of the phenomenon of beats. Show that the beat frequency is equal to the difference of frequencies of the component oscillations. 2+4+4=10

6. (a) Show that intensity of sound wave at a point is given by

$$I = \frac{P_{rms}^2}{\rho V}$$

where  $P_{rms}$  is root mean square velocity of excess pressure,  $\rho$  is the density of the gaseous medium and  $V$  is the velocity of sound. 6

- (b) If intensity level of a sound is increased by 1 dB, then calculate the percentage increase of intensity of the sound. 4

7. (a) A transverse wave is represented by

$$y = y_0 \sin \frac{2\pi}{\lambda}(vt - x)$$

Find the value of  $\lambda$  for which the maximum particle velocity becomes equal to twice the wave velocity. 4

- (b) For a particle executing SHM, show that its average kinetic energy is equal to half of its total energy. 6

SECTION—II

( Ray Optics )

( Marks : 20 )

Answer any four questions

8. State Fermat's principle for stationary path with the mathematical relation of optical path variation. Establish the Fermat's principle for refraction at curved surface.

2+3=5

9. What do you mean by translation matrix? Find out an expression of translation matrix which transforms a ray  $\begin{bmatrix} \lambda_1 \\ x_1 \end{bmatrix}$  into the ray  $\begin{bmatrix} \lambda_2 \\ x_2 \end{bmatrix}$  during translation through a distance  $d$  in a homogenous medium.

1+4=5

10. A concave lens is placed at a distance of 25 cm in front of a concave mirror of focal length 20 cm. It is found that a pin placed at a distance of 45 cm in front of the lens coincide with its own inverted image formed by the combination. Using refraction matrix, find the focal length of the lens. 5

11. What is spherical aberration in a lens? What is circle of least confusion in this aberration? Find out the condition for minimisation of spherical aberration by using two lenses separated by finite distance. 1+1+3=5

12. Write a short note on any one of the following : 5

(a) Chromatic aberration and its elimination

(b) High power oil immersion objective

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