2018

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 $-\pi \le x \le \pi$ and outside it is periodic. State whether the function is even or odd within $-\pi \le x \le \pi$. 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 λ 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, ρ 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 λ 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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