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3 (Sem-1) PHY M2

2021

(Held in 2022)

PHYSICS

(Major)

Paper : 1:2

(Waves, Oscillations and Ray Optics)

Full Marks : 60

Time : Three hours

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

SECTION-I

(Marks : 40)

1. Answer the following questions : $1 \times 4 = 4$

(a) What is reverberation of sound ?

(b) What is the phase difference between velocity and acceleration of a particle executing SHM ?

(c) What is the ratio between the intensities of first and third harmonics produced in a string plucked at the midpoint ?

(d) What simplification is obtained in the Fourier series if the function is odd ?

Contd.

2. (a) What is sharpness of resonance? Explain the effect of damping on the sharpness of resonance. 2

(b) A particle is executing SHM of period 4 sec amplitude 5 m. Find the velocity when the particle is 2 m away from the mean position. 2

(c) Write the properties of stationary waves. 2

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

(a) Derive the expression for average energy density of a plane progressive wave. 5

(b) What is velocity resonance? Show that at velocity resonance the maximum velocity is inversely proportional to the damping. 5

(c) Show that the acoustic intensity for a plane wave is the product of the r.m.s. sound pressure and the r.m.s. particle velocity. 5

4. (a) State Fourier theorem. Analyse with the help of Fourier theorem a square periodic wave given by

$$y = A \text{ (constant) for } 0 \leq t \leq \frac{T}{2}$$

$$= 0 \quad \text{for } \frac{T}{2} \leq t \leq T$$

Also plot the Fourier synthesis with first four terms. 2+6+2=10

Or

(b) Derive an expression for growth and decay of the acoustic energy density with time in an enclosure. Give Sabine's definition of reverberation time. 8+2=10

(c) Obtain the differential equation for the transverse vibration of a stretched string. Solve the differential equation by the method of separation of variables. 5+5=10

Or

(d) Two simple harmonic motions act simultaneously on a particle at right angles to each other. Show that the path of the particle will be an ellipse when the two motions have the same period but different amplitudes and initial phases. What happens when the phase difference between the motions

are (i) 0, and (ii) $\frac{\pi}{2}$? 6+(2+2)=10

SECTION-II

(Marks : 20)

5. (a) What is Fermat's principle? 1
 (b) What is circle of least confusion? 1
 (c) What are conjugate foci? 1

6. (a) Explain coma in case of aberration in optics. 2

Or

- (b) What is achromatic doublet? 2

7. (a) Establish the refraction matrix for refraction of a ray of light at a spherical surface separating media of refractive indices n_1 and n_2 . 5

Or

- (b) Find the condition of achromatism of two thin lenses separated by a small distance. 5

8. Answer **either** (a) **or** (b):

- (a) (i) Using Fermat's principle, establish the laws of reflection of light at a plane surface. 5

- (ii) Obtain the conjugate foci relation for refraction at a single spherical surface with pole as origin. 5

Or

- (b) Deduce Helmholtz equation showing the relation between linear and angular magnification of two conjugate planes in an optical system. Indicate how the equation is modified (i) when one of the conjugate planes is at infinity, and (ii) when the system is telescopic.

6+2+2=10