

2013

PHYSICS

( Major )

Paper : 1.2

Full Marks : 60

Time : 2½ hours

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

SECTION—I

( Marks : 40 )

1. (a) What simplification is obtained in the Fourier series if the function is odd? 1
- (b) The e.m.f. equation of a series L-C-R a.c. circuit in complex form is

$$L \frac{d^2 q}{dt^2} + R \frac{dq}{dt} + \frac{q}{c} = V e^{j\omega t}$$

Mention the vibration analogous to the system. 1

- (c) What do you mean by the term 'optimum reverberation time'? 1

- (d) Define stationary wave. 1
- (e) What is the intensity of a tone of 1 kHz which corresponds to the threshold audibility? 1
- (f) A Lissajous figure is produced by superposing a vertical SHM of unknown frequency and a horizontal SHM of frequency 2 kHz. If the ratio of the number of cuts made by horizontal line to that made by the vertical line is  $\frac{3}{2}$ , then what is the vertical frequency? 1
2. (a) A particle executing SHM of period 8 sec, amplitude 4 m. Find the velocity when the particle is 2 m from the mean position. 2
- (b) A wave of frequency 500 Hz has a wave velocity of  $340 \text{ ms}^{-1}$ . What is the phase difference between two points along the line of wave propagation separated by a distance of 17 cm? 2
3. Answer any two questions :  $5 \times 2 = 10$
- (a) What is velocity resonance? Show that at velocity resonance, the maximum velocity is inversely proportional to damping.

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

(c) An increase in pressure of 100 kPa causes a certain volume of water to decrease by  $5 \times 10^{-3}$  percent of its original value. Find the speed of sound in water (density of air is 1 g/cc).

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

Or

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

(b) State Fourier's theorem. Analyze with the help of Fourier's theorem, a square periodic wave given by

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

$$= -A \text{ (constant) for } T/2 \leq t \leq T$$

Also plot the Fourier synthesis with first four terms.

2+6+2=10

Or

Define SHM. What is the relation between a SHM and a uniform circular motion? How can you generate a uniform circular motion from two mutually perpendicular SHM? Also show that a SHM is equivalent to two opposite circular motions.  $1+1+4+4=10$

SECTION—II

( Marks : 20 )

5. What is circle of least confusion? 1
6. (a) Explain coma in case of aberration in optics. 2
- (b) Define principal plane and principal points of an optical system. 2
7. Answer any one question : 5
- (a) Establish the refraction matrix for the refraction of a ray of light at a spherical surface separating media of refractive indices  $n_1$  and  $n_2$ .

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

8. Answer any one question :

10

- ✓ (a) Deduce the 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.

$$6+2+2=10$$

- (b) Derive the condition of achromatism for two thin lenses of focal length  $f_1$  and  $f_2$  (i) when they are made of different materials but placed in contact and (ii) when they are made of the same material but separated by a distance.

$$5+5=10$$

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