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

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

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 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 : 5×2=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 5×10^{-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

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

$= -A$ (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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