2014

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)* If two waves are represented by $x = a\sin\left(\omega t + \frac{\pi}{6}\right)$ and $x' = a\cos\omega t$, then what is the phase difference between the two waves? 1

(b) What is the arithmetic intensity ratio of sound wave corresponding to a change of 1 dB? 1

(c) What is the ratio between the intensities of first and third harmonics produced in a spring plucked at the midpoint? 1

(d) Define a stationary wave. 1

(e) What simplification is obtained in the Fourier series if the function is even? 1

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

2. (a) "Initial conditions of a plucked string are static, while those of a struck string are dynamic." Justify the statement. 2

(b) Distinguish between phase velocity and group velocity. 2

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

(a) 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.

(b) A massless spring whose upper end is fixed to a rigid support carries a horizontal disc of mass 100 g at the lower end. It is observed that the system oscillates with a frequency of 10 kHz and the amplitude of the damped oscillations reduces to half its undamped value in one minute. Calculate *(i)* the resistive force constant and *(ii)* its quality factor.

(c) Deduce the expression for the energy of a string vibrating transversely.

4. (a) 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 is *(i)* zero and *(ii)* $\frac{\pi}{2}$? 6+2+2=10

Or

(b) Explain mathematically how a stationary wave is formed due to superposition of two waves. Find the positions of displacement nodes and antinodes. Derive the expression of pressure to show that the pressure nodes coincide with the displacement antinodes. 4+3+3=10

(c) Analyze, with the help of Fourier theorem, a square periodic wave given by

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

$$= 0 \qquad \text{for } \frac{T}{2} \le t \le T$$

Also plot the Fourier synthesis with first four terms. 6+4=10

Or

(d) Find the expression of velocity of a longitudinal wave in a thin solid bar. Modify the expression using bulk modulus, rigidity modulus and Poisson's ratio so that it can be applicable for an extended solid medium. 6+4=10

SECTION—II

(*Marks* : 20)

5. State Fermat's principle of least action. 1

6. (a) What is achromatic doublet? 2

(b) In the matrix formalism, what advantage do we get if we consider the lens to be thin? 2

7. Find the condition of achromatism of two thin lenses separated by a small distance. 5

Or

Using matrix method, find the equivalent focal length of two lenses in contact in air of focal lengths f_1 and f_2.

8. Answer any *one* question :

(a) (i) Show that spherical refracting surface is aplanatic with respect to certain position of the object. 6

(ii) Distinguish between pin cushion and barrel-shaped distortion. 4

(b) (i) Establish Fermat's principle from refraction of light at a spherical surface. 5

(ii) Obtain the expression for lateral magnification of image produced by a convex lens. 5

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