

2012

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) Indicate the type of motion described by the equation

$$m\ddot{x} = F_0 \cos pt - kx - R\dot{x} \quad 1$$

- (b) What is the displacement of the particle in simple harmonic motion in one-time period? 1

- (c) A sine wave is travelling in a medium. A particular particle has zero displacement at a certain instant. What is the displacement of the particle closest to it having zero displacement? 1

- (d) When a sound wave is refracted from air to water then which of the following will remain unchanged? 1  
Wave number, wavelength, wave velocity, frequency
- (e) On the basis of absorption coefficient, distinguish between live room and dead room. 1
- (f) When a particle is subjected to two simple harmonic motions  $x = a \cos \omega t$  and  $y = b \cos(\omega t + \alpha)$  at right angles to each other, it follows a uniform circular motion. What is the value of  $\alpha$  and relation between  $a$  and  $b$ ? 1
2. (a) A simple harmonic oscillator of mass 0.2 g has an amplitude 4 cm. Its velocity at zero displacement is  $1 \text{ ms}^{-1}$ . Find the frequency and the energy of oscillation. 2
- (b) Distinguish between phase velocity and group velocity. 2
3. Answer any two questions :  $5 \times 2 = 10$
- (a) A microphone emits a 1 kHz pure tone having an intensity level of 65 dB. Calculate the actual intensity (reference intensity =  $10^{-12} \text{ Wm}^{-2}$ ) and the loudness level of the sound. When another source of the same intensity is switched on, calculate the increase in the intensity level in dB.

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- (b) Determine the velocity of longitudinal waves in a thin solid rod in terms of Young's modulus and the density of the material of the rod.
- (c) Deduce the expression for the energy of the string vibrating transversely.
4. (a) Write the differential equation for the damped simple harmonic oscillation of a system from the energy principle and solve it. Discuss the condition for underdamped motion. Draw the time-displacement graph for this case.

2+3+3+2=10

Or

What is a stationary wave? Discuss how a stationary wave is formed due to the superposition of two plane harmonic waves of same amplitude and frequency, propagating in opposite directions. Show that in a stationary wave the pressure nodes coincide with the displacement antinodes and vice versa.

1+5+4=10

- (b) State Fourier's theorem. What simplification is obtained in the Fourier series if the function is odd? Analyse, with the help of Fourier series, a waveform given by

$$f(t) = \frac{A}{T}t, \quad \text{for } 0 < t < T$$

(A = constant)

Also plot the Fourier synthesis with first four terms.

$$2+1+5+2=10$$

Or

Define eigenfunctions, eigenvalues and eigenfrequencies for transverse vibration of a stretched string. Obtain the amplitudes of the different frequencies of a uniformly stretched string with two ends fixed when it is struck over a small region at a distance  $h$  from one end. Assume that the region moves with the instantaneous velocity  $v$  at time  $t = 0$ .

$$3+7=10$$

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SECTION—II

( Marks : 20 )

5. What is the meaning of an achromatic system? 1
6. (a) In the matrix formalism what advantage do we get if we consider the lens to be thin? 2
- (b) What do you mean by aplanatic surface? 2
7. Answer any one question : 5
- (a) Using matrix method, find the equivalent focal length of two lenses in contact in air of focal lengths  $f_1$  and  $f_2$ .
- (b) Establish Fermat's principle from refraction of light at a spherical surface.
8. Answer any one question :
- (a) (i) Explain the causes of chromatic aberration of lens. Deduce an expression for longitudinal chromatic aberration. 2+5=7

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- (ii) An achromatic converging combination of focal length 50 cm is formed with a convex lens of crown glass and a concave lens of flint glass placed in contact with each other. Calculate their focal lengths if the dispersive powers of the crown glass and flint glass are respectively 0.03 and 0.05. 3
- (b) (i) With respective ray diagrams, explain what you understand by coma, astigmatism and distortion in case of aberration in optics. 6
- (ii) Obtain the expression for lateral magnification of image produced by a convex lens. 4

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