

212453
CENTRAL UNIVERSITY OF HARYANA

End Semester Examinations January 2023

Programme: Integrated B.Sc. M.Sc. (Chemistry/Mathematics)

Semester: III

Session: 2022-23

Course Title: Waves and Optics (GE)

Max. Time: 3 Hours

Course Code: SBS PHY 03 301 GE 4004

Max. Marks: 70

Instructions:

- Question no. 1 has seven parts and students need to answer any four. Each part carries three and half marks.
- Question no. 2 to 5 have three parts and student need to answer any two parts of each question. Each part carries seven marks.

- Q1. (a) The equation of a transverse wave on a string is: $y = (2.0\text{mm}) \sin [(20\text{m}^{-1})x - (600\text{s}^{-1})t]$. The tension in the string is 15 N. Find the wave speed and linear density of this string in grams per meter
- (b) In which of the following: air, water, vacuum, and steel; the speed of sound will be highest and in which it will be the lowest. Justify your answer.
- (c) An object undergoing simple harmonic motion takes 0.25 s to travel from one point of zero velocity to the next such point. The distance between those points is 36 cm. Calculate the (i) period, (ii) frequency, and (iii) amplitude of the motion.
- (d) Green light of wavelength $0.51 \mu\text{m}$ from a narrow slit is incident on a double slit. If the overall separation of 10 fringes on a screen 200 cm away is 2 cm, find the slit separation.
- (e) Newton's rings are observed in reflected light of $\lambda = 5.9 \times 10^{-5} \text{ cm}$. The diameter of the 10th dark ring is 0.5 cm. Find the radius of curvature of the lens.
- (f) Deduce the missing orders for a double slit Fraunhofer diffraction pattern, if the slit widths are 0.16 mm and they are 0.8 mm apart.
- (g) Is diffraction of light a wave phenomenon or ray phenomenon? Discuss briefly.
- (4 × 3.5 = 14)
- Q2. (a) Two simple harmonic oscillators are oscillating with same frequency in same direction, but with different phases ϕ_1 and ϕ_2 . Derive the expression for amplitude and phase of resultant motion due to the superposition of these oscillators.
- (b) What are Lissajous' figures? Discuss the composition of two simple harmonic vibrations having equal frequency acting at right angles, and having a phase difference of $\pi/2$.
- (c) Derive wave equation for a transverse wave that is excited by applying tension ' T ' in a string having mass per unit length ' μ '.
- (2 × 7 = 14)
- Q3. (a) Derive the expression for intensity of sound in a medium having mass density ρ . What is intensity of sound of a fighter jet in W/m^2 if it is producing a noise of 120 dB. Take reference intensity I_0 as 10^{-12} W/m^2 .

- (b) What is reverberation time. Derive Sabine's reverberation formula.
- (c) State and prove Bernoulli's theorem. Explain the lifting action of an aeroplane.

(2 × 7 = 14)

- Q4. (a) Find the formula for intensity distribution when two coherent light waves superimpose on each other. What are the conditions necessary for obtaining a sustainable interference pattern?
- (b) What are Newton rings? Discuss the difference between the fringes obtained by using a white light and a monochromatic light.
- (c) Draw a well labeled diagram of Michelson Interferometer. Explain the formation of circular fringes in it.

(2 × 7 = 14)

- Q5. (a) Derive the expression for resultant amplitude in Fraunhofer pattern obtained in a plane diffraction grating and discuss the conditions for maxima and minima in it.
- (b) What is a zone plate? Give its theory. Compare the zone plate with a convex lens.
- (c) What do you understand by polarization of light? Explain how do you distinguish unpolarized, plane polarized, circularly, and elliptically polarized light.

(2 × 7 = 14)