বিদ্যাসাগর বিশ্ববিদ্যালয়
VIDYASAGAR UNIVERSITY

Question Paper

B.Sc. Honours Examination 2022
(Under CBCS Pattern)
Semester - II
Subject: PHYSICS
Paper: C 4-T
Waves and Optics

Full Marks : 40
Time : 2 Hours

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.

Group - A

Attempt any ***four***. 5×4=20

1. The displacement associated with a three-dimensional wave is given by $f(x, y, z, t) = a\cos\left(\frac{\sqrt{3}}{2}kx + \frac{1}{2}ky - \omega t\right)$. Find the direction of wave propagation with respect to x-axis. 5

2. 10 harmonic oscillators (numbered 1, 2, 3 etc) are vibrating at a point with same frequency and amplitude, each having phase difference φ with the previous one. If the total amplitude is zero, find out the phase difference φ. 5

P.T.O.

3. Show that if two vibrations of same frequency and amplitude but phase difference $7\pi/4$ are superimposed along mutually perpendicular directions, the resulting figure will be an ellipse with counter-clockwise vibration. 5

4. Show that for any disturbance to progress along $+ve\ x$ direction with v velocity, it must be mathematically represented by $f(x - vt)$. Using this function, derive the wave equation. 3+2

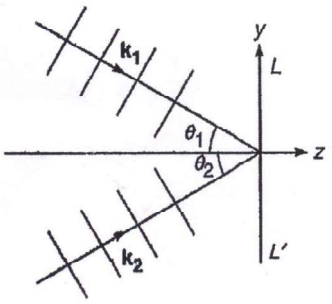
5. Compare convex lens with a zone plate. If you are given a white light source, how would you distinguish between these two by looking at the pattern? 3+2

6. What is the difference between Fresnel and Fraunhofer diffraction? 5

Group - B

Attempt any ***two***. 10×2=20

7. What are the conditions of getting good contrast frin `ges in interference? Two plane waves of wavelength λ are incident on a screen (see figure). What will be the shape of fringes? Find the fringe width. 2+5+3



8. (a) An equiconvex lens is placed on another equiconvex lens. The radii of curvature of two surfaces of the upper lens are 50 cm and those of lower lens are 100 cm. The waves reflected from the upper and lower surfaces of the thin film (formed between the two lenses) interfere to produce Newton's rings. Calculate the radii of the dark rings. Assume, the wavelength of incident wave is $\lambda = 6000$Å.

   (b) Derive an expression for the transmittivity of Fabry Perot etalon having mirrors with reflectivity 98%. 5+5

9. Light is incident on a slit of width 0.1 mm. The diffraction pattern is obtained in the focal plane of a convex lens of focal length 10 cm. Find the width of the central maximum of the intensity pattern for blue light and red light (4000Å and 8000Å respectively). What will happen to the pattern if it is (a) made narrower and (b) made wider gradually? 5+5

P.T.O.

10. A string of length L is tightly stretched with tension T between its two fixed ends $x = 0$ and $x = L$. A hammer blow is given to a small part of length "b" of the string at a distance "a" from the end $x = 0$. As a result, part "b" of the string has an initial velocity V, rest of the string being initially undisturbed. Show that the subsequent vibration of the string is given by :

$$y(x, t) = \frac{4VL}{\pi^2 v} \sum \frac{1}{n^2} \sin\left(\frac{n\pi a}{L}\right) \sin\left(\frac{n\pi b}{2L}\right) \sin\left(\frac{n\pi x}{L}\right) \sin\left(\frac{n\pi v t}{L}\right)$$

where $v = \sqrt{(T/m)}$, m = linear mass density of the string. Assume that tension T remains constant. 10