End Semester Examination, 2022

Semester - II

Physics

PAPER - CC4T

Full Marks : 40

Time : 2 Hours

Group - A

Answer any five questions :

1.a) Two mutually perpendicular oscillations are represented by $x(t)=a\,sinwt$ and $y(t)=b\,sin(2wt+\phi)$ Sketch the Lissajous figure resulting from these oscillations with $\phi=-\Pi$. Find the value of x for which the figure touches the lines $y=\pm b$. 1+1

b) The phase velocity c of surface waves on a liquid of density ρ and surface tension s is given by

$$c^2=\frac{g\lambda}{2\Pi}+\frac{2\Pi s}{\rho\lambda}$$

where g is the acceleration due to gravity and is the wavelength of the wave. Find the expression for the group velocity of the wave. 2

c) Two closed pipes of length 1.1m and 1.175m are sounded together at the fundamental modes. If the speed of sound in air is 340 m/s, determine the number of beats produced per second. 2

d) State clearly Huygen's principle of wave propagation. 2

(Turn Over)

e) The optical path of a monochromatic light is the same if it goes through 2cm of glass or 2.25 cm of water. If the refractive index of glass is 1.50, what is the refractive index of water ? 2

f) What do you mean by fringes of equal width and fringes of equal inclination ? 2

g) Explain the rectilinear propagation of light on the basis of wave theory. 2

h) How many orders would be visible, if the wavelength of incident light is 589 mm and the number of lines in the grating is 104 per mm ? 2

Group - B

Answer any four questions :

2. Show that the amplitude A of the displacement resulting from the superposition of N SHMS all of the same amplitude a and frequency ω but having different phase angles of $\delta_1 = \epsilon, \delta_2 = 2\epsilon, \delta_3 = 3\epsilon \ldots\ldots$ is given by, $A = \frac{a \sin\left(N \epsilon/2\right)}{\sin\left(\epsilon/2\right)}$

   What is the importance of this result ? 4+1

3. Show that the energy density in a stationary wave is twice that of a progressive wave. Also, show that there is no transmission of energy in an ideal stationary wave. 3+2

4. Show that for Young's double slit experiment the shape of the interference fringes are hyperbolic in nature. Why these fringes called non-localized ?

In Fresnel's biprism experiment, a light of wavelength $6000A^0$ falls on biprism. The distance between source and screen is 1.2m and distance between source and biprism is 10cm. The angle of biprism is 1^0. If the fringe width is 0.03 cm. Find out the refractive index of the material of biprism.

5. Newton's rings are formed with a source of light containing two wavelengths λ_1 and λ_2. If m^{th} order dark ring due to λ_1 coincides with the $(m+1)^{th}$ order dark ring due to λ_2. Prove that the radius of the m^{th} dark ring of λ_1 is equal to $\sqrt{\frac{\lambda_1\lambda_2 R}{\lambda_1 - \lambda_2}}$, where R is the radius of curvature of the lower curved surface.

   In a Llyod's mirror experiment calculate the ratio of the intensities at the interference maximum and minima, if the mirror reflects only 75% of the light incident upon it. 3+2

6. What are the conditions to produce circular and straight fringes in Michelson's interferometer ? Calculate the distance between two sucessive positions of the movable mirror of a Michelson's interferometer giving best fringes in case of two component of sodium D-lines of wavelengths 5890 A^0 and 5896 A^0. 3+2

7. Find an expression for the intensity of Fraunhofer diffraction pattern due to a single slit. Discuss the conditions for maxima and minima. 5

Group - C

Answer any one questions :

8. For a stretched string of length l fixed rigidly at two ends, the displacement at a point x at time t is $y(x,t)=\sum_{n=1}^{\infty} sin\frac{n\Pi x}{l}\left(an\ ws\frac{n\Pi ct}{l}+bn\ sin\frac{n\Pi ct}{l}\right)$ in usual notations. Obtain the fundamental frequency in terms of tension and mass per unit length of the string. State the initial conditions that one should use in case of struck and plucked strings.

   For a stretched string of length l the displacement is given by $y(x,t)=\sum_{n=1}^{\infty} c_n\ sin\frac{n\Pi x}{l}cos(w_n t-\phi_n)$ where the symbols have their usual significance. Show that the total energy of the string is $E=\frac{M}{4}\sum_n w_n^2\ c_n^2$, where M is the mass of the string.

   2+2+2+4

9. What is zone plate ? How is it constructed ? Explain its action as a convex lens.

   Derived an expression for its focal length. Also point out the differences between convex lens and the zone plate. 1+2+1+4+2