2022

PHYSICS

(Honours)

Paper : PHY–HC–2026

(Waves and Optics)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer ***any seven*** of the following questions : 1×7=7

   (a) Write the expression of pressure of a longitudinal wave.

   (b) What is a Lissajous figure ?

   (c) Write *one* property of electromagnetic waves.

   (d) What do mean by wavefront ?

   (e) Why are Newton's ring circular in shape ?

(f) Define resolving power of a grating.

(g) What do you mean by diffraction of light ?

(h) Mention *two* methods of producing coherent sources.

(i) Write *one* dissimilarity of a zone plate and a convex lens.

(j) What do you mean by holography ?

2. Answer ***any four*** of the following questions : 2×4=8

(a) What do you mean by temporal and spatial coherence ?

(b) What correction was done by Laplace in Newton's formula for velocity of sound and why ?

(c) In Michelson interferometer 1000 fringes cross the field of view when the movable mirror is displaced through 0.293 *mm*. Calculate the wavelength of light.

(d) In Young's double slit experiment the separation between the slits is 1.2 *mm* and fringe spacing is 0.5 *mm* on a screen kept at a distance of 1 *mm* from the slits. Find the wavelength of the light.

(e) Write *two* uses of Lissajous figures.

(f) Monochromatic light of wavelength 5000 $\mathring{A}$ is diffracted by a grating of 2500 lines per *cm*. Show whether 16th order diffraction is possible.

(g) Define phase and group velocities of waves.

(h) Distinguish between Fresnel and Fraunhofer diffraction.

3. Answer ***any three*** of the following questions : 5×3=15

(a) Discuss the formation of Lissajous figures when the periods of the two vibrations are equal and phase difference is $\pi/2$.

(b) Obtain the expression for velocity of longitudinal waves in a fluid in pipe.

(c) Derive the expression of superposition of two collinear oscillations having equal frequencies.

(d) Draw a neat ray diagram for the experimental arrangement of Newton's rings arrangement. Deduce the relation

$$\lambda = \frac{D_{m+p}^2 - D_m^2}{4pR}$$

for Newton's rings, where D_m and D_{m+p} are the diameters of the mth and $(m+p)$th bright rings, R is the radius of curvature. 1+4=5

(e) A Lloyd's mirror experiment is done with a plane metallic and a microwave source of wavelength 40 *cm*. If the source is 6 *cm* above the plane of the sheet. Find the height of the first maxima above this plane at a distance 4 *m* from the source.

(f) Discuss the phase change due to reflection of light from the surface of a denser medium.

(g) Explain the Fresnel's diffraction due to a straight edge. Show that the separation between successive maxima goes on decreasing as we move away from the region of geometrical shadow. 4+1=5

(h) In a Melde's experiment, when the tension is 100 *gm* and the tuning fork vibrates at right angles to the direction of string, the later is thrown into four segments. If now the tuning fork is set to vibrate along the string, find what additional weight will make the string vibrate in one segment.

4. Answer ***any three*** of the following questions : 10×3=30

(a) Find an expression for the intensity distribution pattern in Fraunhofer diffraction pattern due to a single slit. Discuss the conditions for maxima and minima. 7+3=10

(b) (i) Deduce the expression for velocity of transverse vibrations of stretched strings. 7

(ii) Write the differences between longitudinal and transverse waves. 3

(c) What is Fresnel's half period zone ? Why is it called ? Show that the radii of half-period zones are proportional to the square roots of natural number. 2+2+6=10

(d) (i) Discuss the condition necessary for observing interferences of light. How are these satisfied in a bi-prism ? Explain the interference pattern produced by a bi-prism with white ligth. 1+2+2=5

(ii) Discuss how the Michelson interferometer can be used to measure the wavelength of light. 5

(e) (i) Deduce an expression for resolving power of a telescope. 5

(ii) In a bi-prism arrangement, show that the distance between the virtual images of the source is $d = 2x(\mu - 1)\alpha$, where x is the distance of the source from the bi-prism base, α is the refracting angle of the prism and μ is the refractive index of the material of the prism. 5

(f) What is stationary wave ? How they are formed ? Explain analytically how antinode and nodes are formed in a stationary waves. Show that in a stationary wave the distance between two consecutive antinode or node is half a wavelength of waves. 1+1+6+2=10

(g) (i) Explain the theory of Fabry-Pérot interferometer. 7

(ii) Compare the grating spectra with prism spectra. 3

(h) Write short notes on ***any two*** of the following : 5+5=10

(i) Melde's experiment

(ii) Plucked string

(iii) Hologram its recording and reconstruction

(iv) Zone plate