

U.G. 4th Semester Examination - 2022

PHYSICS

[HONOURS]

Generic Elective Course (GE)

Course Code : PHY-H-GE-T-04

(Wave and Optics)

Full Marks : 40

Time : $2\frac{1}{2}$ Hours*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.*

GROUP-A

1. Answer any **five** questions: $2 \times 5 = 10$
- a) Why when two mutually perpendicular simple harmonic motions given by $x = 2 \cos(pt)$ and $y = 2 \cos(2pt)$ superimpose on a particle, what will be the shape of the path followed by that particle?
- b) Calculate the excess pressure between the inside and outside of a soap bubble of radius 1 cm. The surface tension of soap solution is 3.2×10^{-2} N/m.
- c) What do you mean by a streamlined flow and the turbulent flow of fluid?

[Turn over]

- d) What are the conditions for two sources to be coherent?
- e) Why do the fringes obtained in Fresnel's biprism experiment appear to be straight lines?
- f) What are missing orders in the double-slit diffraction pattern?
- g) A ray of light is incident on the surface of a glass plate at the polarizing angle. Calculate the angle of incidence and angle of refraction (μ for glass plate = 1.732).

GROUP-B

2. Answer any **two** questions: $5 \times 2 = 10$
- a) Show that the velocity of transverse waves along a stretched string of mass per unit length m is given by $\sqrt{\frac{T}{m}}$, where T is the tension in the string. Show that the motion represented by $x = (3 \sin \omega t + 4 \cos \omega t)$ is simple harmonic. $3+2$
- b) Define the time of reverberation. State and explain Sabine's law in connection to the acoustics of the building. Define the coefficient of viscosity of a liquid and find its dimension. $1+2+2$

- c) In Newton's rings experiment the diameter of the 4th and 12th rings are 0.4 cm and 0.7 cm respectively. Find the diameter of the 20th dark ring. Compare between polarized and unpolarized light. 3+2

GROUP-C

Answer any **two** questions: 10×2=20

3. a) Show that the most general solution of one-dimensional wave equation

$$\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2} \frac{\partial^2 y}{\partial t^2}$$

is $y = f(x - vt) + g(x + vt)$ where f and g are arbitrary functions of $x - vt$ and $x + vt$ respectively.

- b) Establish the relation

$$v_g = v_p - \lambda \frac{dv_p}{d\lambda}$$

between the phase velocity v_p and group velocity v_g .

- c) Briefly describe Poiseuille's method for determining the coefficient of viscosity of a liquid. 3+3+4

4. a) Find the frequency of oscillation of an object satisfying the differential equation

$$\ddot{x} + 0.693\dot{x} + 9.99x = 0.$$

- b) Water is conveyed through a horizontal tube 0.08 m in diameter and 4000 m in length at the rate 20 litres per second. Assuming only viscous resistance calculate the pressure required to maintain the flow.

- c) In Fresnel's biprism experiment, the light of wavelength 6000Å falls on biprism. The distance between source and screen is 1 m and the distance between source and biprism is 10 cm. The angle of biprism is 1°. If the fringe width is 0.03cm, find out the refractive index of the material of biprism. 3+3+4

5. a) Describe Fraunhofer diffraction due to a single slit for central maxima and prove that the relative intensities of the successive maximum are nearly 1:1/22:1/61.

- b) State and explain Brewster's law.

- c) A grating containing 4000 slits per centimetre is illuminated with a monochromatic light and produces the second-order bright line at a 30° angle. What is the wavelength of the light used? (1 Å = 10⁻¹⁰ m) (3+2)+3+2