

**B.Sc. Semester-II Examination, 2022-23****PHYSICS [Honours]**

Course ID : 22412      Course Code : SH/PHS/202/C-4(T4)

Course Title : Waves and Optics

Time : 1 Hour 15 Minutes

Full Marks : 25

*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.***SECTION-I**

1. Answer any **five** questions: 1×5=5
- a) Define damping coefficient and find its dimension.
- b) The bob of an oscillating simple pendulum is made up of ice. How the time period of the pendulum will change when the ice starts melting?
- c) A plane harmonic wave travelling through a medium is represented (in SI unit) by

$$E_x(y, t) = E_0 \sin 2\pi \left( \frac{y}{3 \times 10^{-7}} - 5 \times 10^{14} t \right).$$

Determine the refractive index of the medium.

*[Turn Over]*

- d) When do you get the phase velocity and group velocity equal?
- e) A diffraction grating of length  $2.5 \times 10^{-2}$  m is illuminated by a light of wavelength 5997Å and 6003Å. Determine the grating element to resolve the said wavelengths in 1st order.
- f) Mention one use of beat.
- g) A double slit experiment is performed in air using monochromatic light of wavelength 5890Å, when the fringe width is found to be 0.36 nm. What will be the fringe width if the whole arrangement is immersed in a liquid of refractive index 1.33?
- h) What is the basic principle of holography?

**SECTION-II**

2. Answer any **two** questions: 5×2=10
- a) A massless spring whose upper end is fixed at a rigid support carries a horizontal disc of mass 100 gm at the lower end. It is observed that the system oscillates with a frequency of 10 Hz and amplitude of the damped oscillations reduces to half its undamped value at 1 minute. Calculate:
- i) coefficient of damping
- ii) natural frequency of oscillation

- iii) force constant of the spring and  
iv) time period of oscillation. 1+2+1+1
- b) Set up the differential equation of motion of a simple harmonic oscillation subjected to a damping force and an external simple harmonic force. Obtain the expression for amplitude and phase angle of the displacement in the steady state. 5
- c) What are Newton's rings? Deduce the expression for fringe width of Newton's ring. 1+4=5
- d) What is Lissajous figures? Two mutually perpendicular simple harmonic motions acting simultaneously on a particle are given by  $x = a_1 \sin \omega t$  and  $y = a_2 \sin(\omega t + \phi)$ . Derive the resultant equation of motion for  $\phi = 90^\circ$  and  $\phi = 0$ . 1+2+2=5

### SECTION-III

3. Answer any **one** question: 10×1=10
- a) i) Briefly discuss the formation of stationary waves for the transverse vibration of a string under tension and fixed at two ends. Obtain the differential equation for the transverse vibration of a stretched string.

- ii) Distinguish between Fresnel diffraction and Fraunhofer diffraction. Calculate the width of the central maximum in Fraunhofer diffraction. What happens when the slit is made narrower? (2+3)+(2+2+1)=10
- b) i) Find the phase velocity for propagation of one-dimensional progressive wave through fluid medium.
- ii) The dispersion relation for microwaves in ionosphere is given by,  $w^2 = w_p^2 + c^2 k^2$ , where  $c$  is the velocity of light in free space and  $w_p$  is a constant depending upon the electron density of the ionosphere. Show that the phase velocity  $c_p$  is greater than  $c$ . 5+5