

PHYS3012

3 Yr. Degree/4 Yr. Honours 3rd Semester Examination, 2024 (CCFUP)

Subject : Physics

Course : PHYS3012 (MAJOR)

(Waves and Optics)

Time: 2 Hours

Full Marks: 40

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Symbols have their usual meaning.

1. Answer any five questions:

2x5=10

- (a) What are beats? Explain using graphical representation.
- (b) Define normal co-ordinates and normal modes of vibration for a coupled oscillator.
- (c) Differentiate between the fringes produced in Interference and Diffraction patterns.
- (d) Compare the intensities of the transmitted beam in two cases: (i) when the polariser and the analyser are parallel and (ii) when they are perpendicular to each other.
- (e) In the Fraunhofer diffraction pattern from a double slit, there are 11 bright fringes within the central diffraction maxima. If each slit is 0.02 cm wide, what will be the separation between the bright fringes?
- (f) What are the differences between the fringes formed in Michelson's interferometer and the Newton's rings apparatus?
- (g) Define Bel and Phon.
- (h) Find the thickness and the refractive index of an anti-reflection coating necessary for a glass lens ($r.i = 1.5$) in air. ($\lambda = 590 \text{ nm}$).

2. Answer any two questions:

5x2=10

- (a) What is Doppler effect? Why is it difficult to observe this effect for the light wave compared to the sound wave? Consider a train is blowing a whistle while passing by a stationary observer. The frequency of sound appears to decrease from 220 Hz to 190 Hz as the train crosses the observer. Find the actual frequency of the whistle. **1+2+2**
- (b) State the essential conditions for the production of a sustained interference pattern. Why is a narrow source used in Fresnel's biprism experiment? Is the light energy destroyed in the region of destructive interference? **2+2+1**
- (c) Explain the terms:
Optic axis, principal plane, uniaxial crystal, positive and negative crystal. **1+1+1+1**
- (d) Define group velocity and phase velocity. Derive the expression of the velocity of a sound wave propagating in a gaseous medium. **2+3**

3. Answer *any two* questions:

$10 \times 2 = 20$

- (a) Distinguish between the Fraunhofer and the Fresnel diffractions. What is a zone plate? Show that a zone plate has multiple foci. Show that the intensity distribution for the diffraction in single slit is given by $= I_0 \frac{\sin^2 \beta}{\beta^2}$, where the symbols have their usual meaning. Hence, deduce the conditions for maxima and minima.

$2+1+2+3+2$

- (b) Describe the construction and the working principle of Fabry-Perot interferometer. Discuss the intensity distribution of the fringes and find the ratio of I_{\max} to I_{\min} .

$6+4$

- (c) A uniform stretched string with two ends fixed is struck over a small region at a distance ' a ' from one end. Assuming that the region moves with initial velocity ' u ', find the general expression for the displacement $y(x, t)$. Prove that the harmonics which have a node at the struck point will be absent from the resultant vibration. For a stretched string of length ' l ' the displacement is given by,

$$y(x, t) = \sum_{n=1}^{\infty} C_n \sin \frac{n\pi x}{l} \cos(\omega_n t - \phi_n)$$

where the symbols have their usual significance. Show that the total energy of the string is $E = \frac{M}{4} \sum_n \omega_n^2 C_n^2$, where M is the mass of the string.

$5+2+3$

- (d) A particle is subjected to two SHMs at right angles to each other, having the same frequency. Show that the resultant locus of the particle is an ellipse. Hence find the locus when the two motions are (i) in phase and (ii) in opposite phase. Show that a uniform circular motion is equivalent to two mutually perpendicular SHMs of the same frequency but with a phase difference of 90° .

$3+2+2+3$