2022

PHYSICS — HONOURS

(Syllabus : 2019-20 and 2018-19)

Paper : CC-4

(Waves and Optics)

Full Marks : 50

The figures in the margin indicate full marks.

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

Question no. **1** is compulsory and ***any four*** from the rest.

1. Answer ***any five*** questions : 2×5

(a) Define relaxation time of damped oscillatory system.

(b) What do you mean by sharpness of resonance?

(c) Find out the relation between group velocity and phase velocity.

(d) State Huygen's principle.

(e) What will happen in Newton's ring experiment if the glass plate is replaced by a plane mirror?

(f) What is the shape of the interference fringes obtained in Michelson's interferometer? Explain.

(g) When will the interference pattern formed by two coherent waves be more distinct for equally intense waves or for waves with widely different intensities? Justify your answer.

2. (a) A particle of mass m is located in a one dimensional potential field where the potential energy of the particle depends on the coordinates x and $V(x) = V_0(1 - \cos\beta x)$. Where V_0 and β are constants. Show that for small values of x the particle will execute simple harmonic motion.

(b) Two mutually perpendicular simple harmonic motion of same period but of different amplitudes and phases act on a particle. Find the expression for the trajectory followed by a particle. Under what condition the trajectory will be circle? 4+(4+2)

3. (a) Find out the expression for displacement of a particle undergoing damped simple harmonic motion and discuss when we get oscillatory damped simple harmonic motion?

(b) Define logarithmic decrement and derive a relation for it. (3+3)+(1+3)

4. (a) For a stretched string of length l, the displacement is given by $y(x, t) = \sum_{n=1}^{\infty} C_n \sin\left(\frac{n\pi x}{l}\right)\cos(\omega_n t - \phi_n)$

(where all symbols have their usual meaning). Show that the total energy is $E = \frac{m}{4}\sum_n \omega_n^2 C_n^2$, where

m is the mass of the string.

(b) What do you mean by longitudinal and transverse wave? Write down the one dimensional differential wave equation and solve it for a plane progressive harmonic wave. 5+(2+3)

5. (a) Discuss briefly the phenomenon of interference with relation to law of conservation of energy.

(b) How does interference take place in thin film? Show that the reflected and transmitted interference patterns are complimentary to each other. 4+(5+1)

6. (a) Show that in two dimensions, the shape of the fringes produced in Young's experiment is hyperbolic. Why are these fringes called non-localized?

(b) What do you mean by fringes of equal width and fringes of equal inclination?

(c) In Newton's ring arrangement with a source emitting two wavelengths λ_1 and λ_2, it is found that the m-th dark ring due to wavelength λ_1 coincides with the $(m + 1)$th dark ring due to λ_2. Show that the radius ρ_m of the m-th dark ring for λ_1, if the radius of curvature of the lens is R, is given by

$$\rho_m = \sqrt{\frac{\lambda_1\lambda_2 R}{\lambda_1 - \lambda_2}}.$$ (3+1)+3+3

7. (a) Find out the missing orders in a double slit diffraction pattern.

(b) A parallel beam of sodium light is allowed to be incident normally on a plane grating having 4250 lines per centimetre and a second order spectral line is observed to be deviated through 30°. Calculate the wavelength of the spectral line.

(c) Explain Rayleigh's criterion of resolution. 4+3+3
