2021

PHYSICS — HONOURS

(2018-19 and 2019-20 Syllabus)

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.

Answer ***question no.* 1** and ***any four*** questions from the rest.

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

(a) 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) Distinguish between amplitude resonance and velocity resonance for forced harmonic oscillation.

(c) What is wavefront?

(d) What are the conditions for two sources to be coherent?

(e) Why the fringes obtained in Fresnel's biprism experiment appear to be straight lines?

(f) Explain the changes you will observe in the grating spectra as we pass from one order to the other, if the radiation is not strictly monochromatic.

(g) What are missing orders in the double slit diffraction pattern?

2. (a) A particle is executing one-dimensional simple harmonic motion. Find out the total energy at any instant and plot its kinetic energy and potential energy as functions of positions.

(b) Show that the motion represented by $x = (3\sin\omega t + 4\cos\omega t)$ is simple harmonic. What is the amplitude of this oscillation?

(c) Two forces act on a particle moving in one dimension : (i) restoring force proportional to instantaneous position and (ii) damping force proportional to instantaneous velocity.

Construct the differential equation of motion for the particle. Solve it for the critically damped case. 3+(2+1)+(1+3)

3. (a) Derive an expression for the average power supplied to a forced oscillator by an external driving force $F = F_0\cos\omega t$.

(b) Find the Q-value of an oscillator in terms of resonance absorption bandwidth.

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(c) Two simple harmonic motions $x = a \sin \omega t$ and $y = b \sin (\omega t + \theta)$) acting on a particle in perpendicular direction. What is the resultant motion when $\theta = 0^o$ and $\theta = 90^o$? 3+3+(2+2)

4. (a) Define the terms phase velocity and group velocity. Establish a relation between them.

(b) Show that the velocity of transverse waves along a stretched string of mass per unit length m is given by $\sqrt{T/m}$, where T is the tension in the string. (3+3)+4

5. (a) What do you understand by 'coherence time' of a source?

(b) Find an expression for fringe-width in case of Young's double slit experiment.

(c) In a Young's double slit experiment with monochromatic light, fringes are obtained on a screen placed at a distance D from the slits. If the screen is moved 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-5} m. If the distance between the slits is 10^{-3} m, calculate the wavelength of the light used. 2+4+4

6. (a) Derive an expression for the wavelength of monochromatic light source used in Newton's ring experiment in terms of diameter of rings and of curvature (R) of the lens used.

(b) 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.

(c) What do you mean by fringes of equal inclination? 5+3+2

7. (a) What is Zone Plate? Derive an expression for its focal length.

(b) A beam of light is incident normally on a diffraction grating of width 2 cm. It is found that at 30 degree the nth order diffraction maximum for wavelength 500 nm superpose on the $(n + 1)$th order diffraction maximum for wavelength 400 nm. How many lines per cm does the grating have? Find out whether first order spectrum from this grating can be used to resolve wavelengths 580 nm and 580.2 nm. (1+4)+5