B.Sc. 2nd Semester (Honours) Examination, 2022 (CBCS)
Subject: Physics
Paper: CC-4
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 word as far as practicable.
Symbols have their usual meanings.

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Group-A

1. Answer any five questions **2x5= 10**

(a) A transverse harmonic disturbance is produced in a string. The maximum transverse velocity is 3 m/s and the maximum transverse acceleration is 90 m/s^2. If the wave velocity is 20 m/s, then find the wave form.

(b) The coherence length of sodium D_2 line is 2.5 cm. Calculate the coherence time and spectral width of the line. Take λ= 589.0 nm.

(c) Distinguish between fringes of equal thickness and of equal inclination with example.

(d) What is the difference between an ordinary image and a holographic image?

(e) Two stars having an angular separation of 1 x 10^{-6} radian emit light of wavelengths 577 nm and 579 nm respectively. How large a diameter of the lens in the telescope is needed to separate the two wavelengths present?

(f) A very thin film whose thickness is small compared with the wavelength of light is viewed in reflected light at normal incidence. Explain what the film would look like.

(g) 2^{nd} overtone of a closed organ pipe is in resonance with 3^{rd} harmonic of an open pipe. Find the ratio of $L_{closed} : L_{open}$.

(h) A particle is simultaneously subjected to two simple harmonic motions in the same direction, each of frequency 5 Hz. If the amplitudes are 0.005 m and 0.002 m respectively and the phase difference between them is 45^0, find the expression for the resultant displacement as a function of time.

Group-B

Answer any two of the following: **5x2=10**

2. (i) Briefly discuss the formation of stationary waves for the transverse vibration of a string fixed at the two ends.
(ii) A string fixed at both ends has consecutive standing wave modes for which distances between adjacent modes are 22 cm and 20 cm respectively. Find (i) the mode of vibration and (ii) the minimum possible length of the string. 2+3

3. (i) What is 'beat frequency'? Analytically derive the expression for beat frequency.
(ii) The frequencies of two sound sources are 256 Hz and 258 Hz. At t=0 the intensity of sound is maximum, then what would be the phase difference at t= $\frac{1}{8}$ sec? 1+2+2

4. (i) Why is it necessary to use narrow source for Young's double slit experiment and extended source for Newton's ring experiment?
(ii) In Young's double slit experiment the separation between second maxima and fourth minima (on the same side of central maxima) is 0.5 m. Find the fringe width. 3+2

5. (i) Derive the expression for condition of minima for the fringes formed by the reflected light in Newton's ring experiment.
(ii) In Newton's ring experiment the diameter of the 5^{th} dark ring is reduced to half its value after placing a liquid between glass plate and convex surface. Calculate refractive index of liquid.
3+2

Group-C

Answer any two of the following: **10x2=20**

6. (i) What is meant by Rayleigh criterion of resolution? Derive an expression for the resolving power of a plane diffraction grating.
(ii) Examine whether the two sodium lines of wavelengths 589.0 nm and 589.6 nm will be resolved in the (i) 1^{st} order or (ii) 2^{nd} order by a grating of width 2.54 cm having 30 lines per mm.
2+5+3

7. (i) What is Zone plate? Explain its action as a convex lens. Derive an expression for its focal length.
(ii) The radius of the central zone of a zone plate is 1.55 mm. If a point source of light of wavelength 589.3 nm is placed at a distance of 6 m from it, find the position of the first image.
2+3+3+2

8. (i) What are group velocity and phase velocity? Find the relation between them in dispersive and non dispersive medium.
(ii) Obtain an expression for the velocity of a plane longitudinal wave in a liquid medium.
5+5

9. (i) Obtain the intensity expression for Fraunhofer diffraction pattern due to a single slit. Discuss the conditions for maxima and minima. How is the size and the intensity of the central diffraction band affected if the width of the slit is made double the original width?
(ii) A parallel beam of light of wave length 500 nm is incident normally on narrow slit of width 0.2 nm. The Fraunhofer diffraction is observed on a screen which is placed at focal plane of the lens (lens is placed very close to the slit) of focal length 20 cm. Calculate the width of the central maximum and also the distance between the first two minima. 7+3