# B.Sc. 2nd Semester (Honours) Examination, 2023 (CBCS)

## Subject : Physics

## Course : CC-IV

**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.*

**1.** Answer *any five* of the following questions: 2×5=10

(a) Distinguish between fringes of equal thickness and of equal inclination giving an example of each.

(b) A pipe open at both ends has a fundamental frequency $f$ in air. The pipe is dipped vertically in water so that half of its length is in water. What would be the fundamental frequency of the air column now?

(c) In a diffraction grating experiment you notice that 3rd, 6th and 9th order maxima are missing. What conclusion would you draw from this spectra?

(d) Explain how the conditions for obtaining sustained interference pattern are satisfied in case of interference by division of wave front and by division of amplitude.

(e) Elucidate the concept of normal modes of stretched strings.

(f) Show that in Fraunhofer diffraction in a single slit, the first minima on either side of central maxima is given by $\theta = \frac{\lambda}{a}$ where $a$ is the width of the slit and $a >> \lambda$.

(g) In Lloyd's mirror experiment, the intensity ratio of bright and dark fringes is 9 : 1. Calculate the amplitude ratio of the same.

(h) In an interference experiment, the path difference between two beams is 5 metres. If the coherence time be $10^{-9}$ sec., examine whether it is possible to have interference pattern.

**2.** Answer *any two* of the following questions: 5×2=10

(a) (i) Show that for a film, whose thickness is much less compared to the wavelength used, appears perfectly dark when seen by reflected light.

(ii) Find the thickness of the soap film that gives constructive second order interference of reflected light ($\lambda = 600$ nm). The refractive index of the film is 1.33 (Assume, parallel beam of incident light is directed at 30° to the normal). 3+2

(b) Explain the principle of holography. State the characteristics of a holographic image. 3+2

(c) (i) Distinguish between dispersive power and resolving power of a grating.

(ii) Consider two gratings, one of width 2 cm has 2000 lines and the other of width 1 cm has 1000 lines. Compare their angular dispersion and resolving power in the second order. 3+2

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(d) (i) What is Fresnel's half period zone?

(ii) Show that the amplitude due to large wave front is just half that due to the first half-period zone acting alone.

(iii) A circular aperture of 1.2 mm diameter is illuminated by plane waves of monochromatic light. The diffracted light is received on a distant screen which is gradually moved towards the aperture. The centre of the circular path of light first becomes dark when the screen is 30 cm from the aperture. Find the wavelength of light. 1+2+2

**3.** Answer *any two* of the following questions: 10×2=20

(a) (i) The intensity distribution in a Fraunhofer double slit diffraction pattern is given by $I = I_0 \left(\frac{\sin^2 \alpha}{\alpha^2}\right) \cos^2 \beta$ where $I_0$ = intensity of the central maximum, $\alpha = \frac{\pi}{\lambda} a \sin\theta$, $\beta = \frac{\pi}{\lambda}(a+b)\sin\theta$, $a$ = slit width, $b$ = width of the opaque space, $\theta$ = angle of diffraction, $\lambda$ = wavelength of light used. Deduce the conditions for maxima and minima. Graphically show the distinguishing feature of this double slit pattern.

(ii) Light of wavelength 640 nm incident normally on a diffraction grating. The line separation is $3.3 \times 10^{-6}$ m. What is the total number of bright spots that can be observed? 6+2+2

(b) (i) Discuss how you will determine the difference of wavelengths of two close spectral lines with the help of Michelson's Interferometer.

(ii) An incident beam contains two close spectral lines of wavelengths $\lambda_1$ and $\lambda_2$ with a mean wavelength 589.3 nm. Interference fringes are observed in the field of view close to the central region and for two successive indistinctness, the plate separation is changed from 0.693 mm to 0.988 mm. Calculate $\lambda_1$ and $\lambda_2$.

(iii) When a narrow monochromatic source of light ($\lambda$ = 589.3 nm) is placed at a distance of 50 cm from the biprism (r.i. = 1.5), width of the fringes obtained on a screen placed 1 m from the biprism is found to be 0.12 mm. Find the obtuse angle of the biprism. 4+3+3

(c) (i) Find the resultant of two simple harmonic vibrations at right angles, with their periods in the ratio 1 : 2 and with a phase difference of (i) 0 and (ii) $\frac{\pi}{2}$ (keeping amplitude same for both the vibrations).

(ii) A pipe of length 85 cm is closed from one end. Find the number of possible natural oscillations of air column in the pipe whose frequency lies below 1250 Hz. $V_{\text{sound in air}} = 340 m/s$. 7+3

(d) (i) Show that the velocity of transverse wave along a stretched string is given by $c = \sqrt{\frac{T}{m}}$ where $T$ is the tension and $m$ is the mass per unit length.

(ii) Starting from one-dimensional differential wave equation show that a string of infinite length can sustain any arbitrary frequency of vibration. 5+5