



'সমানো মন্ত্র: সমিতি: সমানী'

**UNIVERSITY OF NORTH BENGAL**

B.Sc. Honours 2nd Semester Examination, 2023

**CC4-PHYSICS**

Time Allotted: 2 Hours

Full Marks: 40

*The figures in the margin indicate full marks.*

**GROUP-A**

1. Answer any **five** questions from the following: 1×5 = 5
- (a) If  $\psi_1$  and  $\psi_2$  be the two solutions of the differential wave equation then show that  $(\psi_1 + \psi_2)$  would be a solution of the same.
  - (b) What are Fresnel's half-period zones? Why are they so called?
  - (c) A diffraction grating of 2 cm wide is just able to resolve sodium D-lines in second order. Find the number of rulings per cm.
  - (d) Write the expression for velocity of sound waves in a gaseous medium and explain the terms involved.
  - (e) What is Rayleigh's criterion of limit of resolution of an optical instrument?
  - (f) Calculate the distance between two successive positions of the movable mirror of a Michelson's interferometer giving distinct fringes in the case of sodium light having lines of wavelength 5890 Å and 5896 Å.
  - (g) Why light waves can be polarised but sound wave cannot?
  - (h) What would happen in Newton's ring experiment when air in interspace is replaced by transparent liquid?

**GROUP-B**

**Answer any three questions from the following**

5×3 = 15

2. (a) What do you mean by fringes of equal inclination? Explain with suitable ray diagram. 2+3
- (b) In a Fresnel's biprism experiment with white light, it is observed on the screen that the separation between maxima of violet light with wavelength 400 nm and the red light with wavelength 700 nm, in the first order is 1.5 mm. If the distance between the slit and the biprism be 5.7 mm and the distance between the slit and the screen be 50 cm, find the value of acute angle of the biprism in unit radian. (Refractive index of the material of the biprism is 1.5)

3. (a) Monochromatic light from a broad source is incident on a Fabry-Perot interferometer. Draw a suitable ray diagram and show the formation of Haidinger fringes onto the focal plane of the telescope. 3+2
- (b) Calculate the values of inner and outer radii of the 10<sup>th</sup> half period zone for a plane wavefront with respect to a point at a distance of 0.5 m from it. Wavelength of light is 500 nm.
4. (a) How does the double-slit diffraction pattern differ from that produced by a single slit? 3+2
- (b) In Newton's ring experiment, the diameters of the 7<sup>th</sup> and 10<sup>th</sup> ring are 0.3 cm and 0.5 cm respectively. Find the diameter of the 20<sup>th</sup> dark ring.
5. (a) Show that the resultant of two simple harmonic motions of the same period but different amplitudes and phases in perpendicular direction is an elliptic motion.  $2\frac{1}{2}+1\frac{1}{2}+1$
- (b) Show that the disturbance represented by the equation,  $y(x, t) = A \sin 3t \sin 4x$  satisfies the differential wave equation.
- Does it represent a progressive wave? — Justify your answer.
6. What do you mean by beats? A tuning fork  $X$  of frequency 384 Hz gives 6 beats per second when sounded with another tuning fork  $Y$ . On loading  $Y$  with a little wax, the number of beats per second becomes 4. What is the frequency of  $Y$ ? 2+3

### GROUP-C

**Answer any two questions from the following**

10×2 = 20

7. (a) Obtain the differential equation of vibration of a uniform string of length  $L_1$  stretched between the fixed ends  $x = 0$  and  $x = L_1$ . Hence find an expression for the transverse displacement  $y(x, t)$  at any point of the string excited by striking. (3+4)+3
- (b) A stretched wire is made to vibrate transversely and then longitudinally both in fundamental modes.
- If the stretching load is 5 kg wt, the diameter of the wire is 0.5 mm and Young's modulus of the material of wire is  $2 \times 10^{12}$  dyne/cm<sup>2</sup>. Calculate the ratio of longitudinal frequency to transverse frequency.
8. (a) The phase velocity of a wave in a medium is given by, 5+2+3

$$v_p = \frac{c}{a + \frac{b}{\lambda^2}}$$

where 'a', 'b' and 'c' are constants and 'λ' is the wavelength. Prove that the group velocity is given by  $v_g = v_p - \frac{2bv_p^2}{c\lambda^2}$ .

- (b) Write down the expression of average energy density of a stationary wave and explain each term involved in it.
- (c) Show that the average energy density contained in a stationary wave is twice that for a progressive wave.
9. (a) Apply Huygen's principle to verify the laws of reflection of a plane wave at plane surface. 5+3+2
- (b) State the conditions to be fulfilled for the production of interference fringes.
- (c) Show that the interference patterns in the reflected and transmitted light in thin film are complementary to each other.
- 10.(a) Why doesnot a wavefront propagate backwards? 2+3+3+2
- (b) How will you test the flatness of a surface by interference?
- (c) Distinguish between Fresnel diffraction and Fraunhofer diffraction.
- (d) Calculate the radius of the first zone in a zoneplate if the focal length is 20 cm for light of wavelength  $5000 \text{ \AA}$ .

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