



'সমানো মন্ত্র: সমিতি: সমানী'

**UNIVERSITY OF NORTH BENGAL**  
B.Sc. Honours 2nd Semester Examination, 2022

**CC4-PHYSICS**

**WAVES AND OPTICS**

Time Allotted: 2 Hours

Full Marks: 40

*The figures in the margin indicate full marks.  
All symbols are of usual significance.*

**GROUP-A**

1. Answer any **five** questions from the following: 1×5 = 5
- (a) What is the principle of superposition of waves?
  - (b) What is the relation between phase velocity, frequency and wavelength of a harmonic wave?
  - (c) Calculate the absolute intensity of a 60 dB sound. Given the standard intensity as  $10^{-12} \text{ W/m}^2$ .
  - (d) What would be the change in interference pattern when monochromatic light is replaced by white light in Michelson's interferometer?
  - (e) Does refractive index of a medium depend on the frequency of the wave? — Explain.
  - (f) Show that the restoring force on a simple harmonic oscillator is conservative in nature.
  - (g) Is the conservation of energy principle violate in interference? — Explain.

**GROUP-B**

**Answer any three questions from the following** 5×3 = 15

2. What are phase velocity and group velocity of wave? Derive the relation between them. 2+3
3. Let  $c$  be the speed of sound in a gas medium of  $\gamma=1.4$ . Show that the r.m.s. speed  $v$  of the gas molecules is  $v_{\text{r.m.s.}} = \left(\frac{3}{1.4}\right)^{1/2} c$ . 5
4. How does interference take place in thin films? What do you mean by fringes of equal thickness, fringes of equal inclination and fringes of equal chromatic order? 2+3

5. Explain the concept of coherence. Discuss temporal and spatial coherence. How does the visibility of fringes depend on the degree of coherence? 2+3
6. What happens in the diffraction pattern due to a single slit when the slit width is gradually increased? Explain what is meant by resolving power of a diffraction grating. 2+3

**GROUP-C**

**Answer any two questions from the following**

10×2 = 20

7. (a) Obtain an expression for the velocity of a plane longitudinal wave in a fluid medium. 5
- (b) The intensity level in a conversation is 70 dB above the threshold of  $10^{-12} \text{ W/m}^2$ . Calculate the amplitude of vibration of the air particles for the sound wave. Given, velocity of sound = 350 m/s, density of air = 1.25 g /litre, mean frequency = 500 Hz. 3
- (c) Write down the expression of average energy density of a stationary wave and explain each term. 2

8. Discuss the formation of fringes by Lloyd's single mirror and explain why the central fringe is black. Find an expression for fringe width. In what respect Lloyd's mirror fringes differ from those of biprism fringes? 3+2+2+3

9. (a) What is Fresnel's half period zone? Why is it so-called? Prove that the area of a half period zone on a plane wavefront is essentially independent of the order of the zone. 1+1+3
- (b) Show that the intensity distribution for the diffraction pattern due to a double slit is given by, 3

$$I = 4I_0 \frac{\sin^2 \alpha}{\alpha^2} \cos^2 \gamma$$

where the symbols have their usual significance.

- (c) Mention two important applications of holography. 2

- 10.(a) Show that the diameter of the  $m$ -th Newton's ring, when two surfaces of radii  $R_1$  and  $R_2$  are placed in contact, is given by 5

$$\frac{1}{R_1} \pm \frac{1}{R_2} = \frac{4m\lambda}{D_m^2}$$

$\lambda$  being the wavelength of light used.

- (b) Using light of  $\lambda = 5900 \text{ \AA}$ , it is found that in a thin film of air 7.4 fringes occur between two points. Deduce the difference of film thickness between them. 5

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