

2025

(NEP—2020)

(5th Semester)

PHYSICS (MAJOR1)**(Wave Optics)**

Full Marks : 75

Time : 3 hours

*The figures in the margin indicate full marks for the questions***(SECTION : A—OBJECTIVE)**

(Marks : 10)

Tick (✓) the correct answer in the brackets provided :

1×10=10

1. The method of division of wavefront for producing coherent sources is used in

- (a) Fresnel biprism ()
- (b) Newton's ring ()
- (c) Michelson interferometer ()
- (d) thin films ()

2. In a thin film of width t and refractive index μ , if i and r are angles of incidence and refraction, the path difference for interference in transmitted system is

(a) $2\mu t \cos i$ ()

(b) $2\mu t \cos r + \lambda/2$ ()

(c) $2\mu t \cos r$ ()

(d) $2\mu t \cos i + \lambda/2$ ()

3. In the Newton's rings for a reflected system, the central ring is

(a) dark ()

(b) bright ()

(c) No ring at the centre ()

(d) Both dark and bright ()

4. The thickness of a transparent sheet of refractive index μ , introduced in the path of one of the interfering beams of Michelson interferometer, is given by

(a) $t = \frac{n\lambda}{2(\mu - 1)}$, where λ is the wavelength of light and n is the number of fringes ()

(b) $t = \frac{n}{2(\mu - \lambda)}$, where λ is the wavelength of light and n is the number of fringes ()

(c) $t = \frac{\mu\lambda}{2(n - 1)}$, where λ is the wavelength of light and n is the number of fringes ()

(d) $t = \frac{n\mu}{2(\lambda - 1)}$, where λ is the wavelength of light and n is the number of fringes ()

5. Laser radiation is associated with

- (a) spontaneous emission ()
- (b) stimulated absorption ()
- (c) stimulated emission ()
- (d) non-radiative transition ()

6. At a point on a line perpendicular to the plane of the wavefront of Fresnel's half-period zone, the resultant amplitude due to the whole wavefront is equal to

- (a) half the amplitude of the secondary waves from the first half-period zone ()
- (b) the amplitude of the secondary waves from the first half-period zone ()
- (c) twice the amplitude of the secondary waves from the first half-period zone ()
- (d) half the amplitude of the secondary waves from all the half-period zones ()

7. The focal length of a zone plate is

- (a) infinite ()
- (b) $f_m = \frac{m\lambda}{r_m^2}$ ()
- (c) $f_m = \frac{r_m^2}{m\lambda}$ ()
- (d) zero ()

8. In the Fraunhofer diffraction in a double slit, $b = 2a$ then

- (a) all orders of interference maxima are absent ()
- (b) 2, 4, 6, etc., orders of interference maxima are absent ()
- (c) 1, 2, 3, etc., orders of interference maxima are absent ()
- (d) 3, 6, 9, etc., orders of interference maxima are absent ()

9. What is the refractive index of glass if the light of the wavelength 546 nm is plane polarized when reflected at an angle of 60° ?

- (a) $\sqrt{1}$ ()
- (b) $\sqrt{2}$ ()
- (c) $\sqrt{3}$ ()
- (d) $\sqrt{4}$ ()

10. Dextro-rotatory substances rotate the plane of vibration of the incident light

- (a) towards right ()
- (b) towards left ()
- (c) towards left and right both ()
- (d) No rotation of plane of vibration ()

(SECTION : B—SHORT ANSWERS)

(Marks : 25)

Answer *five* questions, taking at least *one* from each Unit :

5×5=25

UNIT—I

1. What are the conditions for sustained interference?
2. Using the principle of superposition, derive the expression for displacement and phase of the resultant wave for the two waves $y_1 = a_1 \sin(\omega t - \phi_1)$ and $y_2 = a_2 \sin(\omega t - \phi_2)$.

UNIT—II

3. The wavelength of two components of *D*-lines of sodium are 5890 Å and 5896 Å. By how much distance be one of the mirrors of Michelson's interferometer moved so as to obtain consecutive positions of maximum distinctness?
4. Light from a 2.5 mW laser source of aperture diameter 1.8 cm and $\lambda = 5000 \text{ Å}$ is focused by a lens of focal length 20 cm. Calculate the area and intensity of image.

UNIT—III

5. Calculate the area of a Fresnel's half-period zone.
6. What are the factors on which the resultant intensity of an *N*-line grating depends? What will happen if $N = 2$?

UNIT—IV

7. Write briefly about the Rayleigh's criterion of resolution.
8. What is a polarimeter? Construct Laurent half-shade polarimeter.

(SECTION : C—DESCRIPTIVE)

(Marks : 40)

Answer *four* questions, taking *one* from each Unit :

10×4=40

UNIT—I

1. (a) Explain the formation of interference fringes in a Fresnel biprism with monochromatic light. Discuss how thickness of a thin transparent sheet can be determined in Fresnel's biprism experiment. 3+4=7
- (b) In a biprism experiment, the fringe width is 10 mm for a wavelength of 5893 Å. If $\frac{y}{x} = 20$, where y is the distance between biprism and screen, while x is the distance between source and biprism. Calculate the refracting angle of the biprism if its refractive index is 1.5. 3
2. (a) Discuss the Newton's rings for a reflected system. 4
- (b) Explain the method of Newton's ring to determine the refractive index of a liquid. 6

UNIT—II

3. (a) Describe the working of Fabry-Perot interferometer. 3
- (b) Write about the three applications of it. 6
- (c) What are the advantages of Fabry-Perot interferometer over Michelson's interferometer? 1
4. (a) What are the characteristics of laser radiation? 3
- (b) What is population inversion and how is it produced? 2
- (c) Define the Einstein's A and B coefficients and establish a relation between the two. 1

UNIT—III

5. Derive the expression for intensity in the Fraunhofer diffraction in a single slit. How does the intensity distribution look like? What will be the effect in the diffraction pattern if white light is used in place of monochromatic light? 7+2+1=10
6. What is a plane diffraction grating? Discuss the grating theory and obtain the expression for resultant intensity. Write the conditions of principal maxima, secondary minima and maxima. 2+5+3=10

UNIT—IV

7. What is a Nicol prism? Discuss the action of it as polarizer and analyser. How are elliptically and circularly polarized lights produced? 2+4+4=10
8. What is optical activity? Write the Fresnel's explanation of rotatory polarization and verify it. 3+5+2=10
