Indian Institute of Technology Patna

Physics Department

PH 301: Tutorial cum Assignment - I

Interference, Diffraction, & Polarization

1. In Young's double-hole experiment, a thin mica sheet (n = 1.5) is introduced in the path of one of the beams. If the central fringe gets shifted by 0.2 cm, calculate the thickness of the mica sheet. Assume d = 0.1 cm and D = 50 cm.
2. In Young's double-hole experiment, interference fringes are formed using sodium light which predominantly comprises two wavelengths (5890 and 5896 Å). Obtain the regions on the screen where the fringe pattern will disappear. You may assume d = 0.5 mm and D = 100 cm.
3. If one carries out Young's double-hole interference experiment using microwaves of wavelength 3 cm, discuss the nature of the fringe pattern if d = 0.1, 1, and 4 cm. You may assume D = 100 cm.
4. In Young's double-hole experiment, calculate I/Imax where I represents the intensity at a point where the path difference is $\lambda/5$.
5. White light falls normally on a transmission grating that contains 1000 lines per centimetre. At what angle will red light (λ_0 = 650 nm) emerge in the second order spectrum?
6. Light having a frequency of 4.0×10^{14} Hz is incident on a grating formed with 10,000 lines per centimetre. What is the highest order spectrum that can be seen with this device?
7. What is the total number of lines a grating must have in order just to separate the sodium doublet (λ_1 = 5896 Å, λ_2 = 5890 Å) in the third order?
8. Consider a plane wave incident normally on a long narrow slit of width 0.02 cm. The Fraunhofer diffraction pattern is observed on the focal plane of a lens whose focal length is 20 cm. Assuming λ = 6000 Å determine the positions of the first and second minima. Also determine the positions of the first and second maxima.

9. Two adjacent plane polarized waves A and B with planes of polarization perpendicular to each other are analyzed by an analyzer. In one orientation of the analyzer the intensity of the wave B is zero. When the analyzer is rotated through an angle 60° from this orientation, the intensities of the two waves are equal. Compare the intensities of the two waves.
10. Horizontally polarized light passes through two ideal linear polarizers with transmission directions making angles of θ and $-\theta$ with the horizontal direction. Find polarization state of the emergent light and its intensity as a function of θ. For what values of θ, no light comes from the second polarizer?
11. Assuming amplitudes of two plane polarized lights as $a_1 = a_2$ and $\theta = 2\pi/3$. Plot the values of E_x and E_y for different values of time and also describe the state of polarization.

    $E_x = a\cos\omega t \qquad and \quad E_y = a\cos(\omega t - \theta)$
12. A left circularly polarized beam (λ_0 = 589.3 nm) is incident normally on a calcite crystal (with its optic axis cut parallel to the surface) of thickness 0.005141 mm. What will be the state of polarization of the emergent beam? For calcite, n_0 = 1.65836 and n_e = 1.48641.
