Indian Institute of Technology Patna

Physics Department

PH 201: Tutorial I

Young's Double Slit Experiment & Multiple Beam Interference

1. In Young's double-hole experiment, the distance between the two holes is 0.5 mm, $\lambda = 5 \times 10^{-5}$ cm, and $D = 50$ cm. What will be the fringe width?

2. 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.

3. 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.

4. 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.

5. In the double-hole experiment using white light, consider two points on the screen, one corresponding to a path difference of 5000 Å and the other corresponding to a path difference of 40,000 Å. Find the wavelengths (in the visible region) which correspond to constructive and destructive interference. What will be the color of these points?

6. In Young's double-hole experiment, calculate $I/I\max$ where I represents the intensity at a point where the path difference is $\lambda/5$.

7. Calculate the resolving power of a Fabry–Perot interferometer made of reflecting surfaces of reflectivity 0.85 and separated by a distance 1 mm at λ = 4880 Å.

8. Calculate the minimum spacing between the plates of a Fabry–Perot interferometer which will resolve two lines with $\Delta\lambda$ = 0.1 Å at λ = 6000 Å. Assume the reflectivity to be 0.8.

9. Consider a monochromatic beam of wavelength 6000 Å incident (from an extended source) on a Fabry–Perot etalon with $n_2 = 1$, $h = 1$ cm, and $F = 200$. Concentric rings are observed on the focal plane of a lens of focal length 20 cm.

   (a) Calculate the reflectivity of each mirror.

   (b) Calculate the radii of the first four bright rings. What will be the corresponding values of m?

   (c) Calculate the angular width of each ring where the intensity falls by one-half and the corresponding FWHM (in mm) of each ring.

10. Consider a monochromatic beam of wavelength 6000 Å incident normally on a scanning Fabry–Perot interferometer with $n_2 = 1$ and $F = 400$. The distance between the two mirrors is written as $h = h_0 + x$. Given $h_0 = 10$ cm:

    (a) Calculate the first three values of x for which we will have unit transmissivity and the corresponding values of m.

    (b) Also calculate the FWHM Δh for which the transmissivity will be one-half.

    (c) What would be the value of Δh if F were 200?
