Interference

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Question No. 1 : Consider interference due to two coherent waves of same frequency and constant phase difference having intensity I and 4I respectively. What is the resultant intensity when the phase difference between these two waves is $\frac{\pi}{2}$ and π

Solution

We know that

$$I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\delta$$

given $I_1 = I$, $I_2 = 4I$, $\delta = \frac{\pi}{2}$

then $I = I + 4I + 2 \times I \times 2I \cos\frac{\pi}{2}$

$$I_{\pi/2} = 5I$$

$$I_\pi = I + 4I + 2 \times I \times 2I \times \cos\pi$$

$$= I + 4I - 4I$$

$$= I$$

Q.2. Two waves of same frequency and constant phase difference having intensities in the ratio 81 : 1, they produce interference fringes. Deduce the ratio of maximum to minimum intensity.

Ans:- We have

$$\frac{I_{max}}{I_{min}} = \frac{I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}}{I_1 + I_2 - 2\sqrt{I_1}\sqrt{I_2}}$$

$$= \frac{\left(\sqrt{I_1} + \sqrt{I_2}\right)^2}{\sqrt{I_1} - \sqrt{I_2}}$$

$$\frac{I_1}{I_2} = \frac{81}{1} = \frac{\sqrt{I_1}}{\sqrt{I_2}} = \frac{9}{1}$$

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$$\frac{I_{max}}{I_{min}} = \frac{(9\sqrt{I_2} + \sqrt{I_2})^2}{(9\sqrt{I_2} - \sqrt{I_2})^2} = \frac{(10)^2 I_2}{(8)^2 I_2}$$

$$= \frac{25}{16}$$

Question 3. Monochromatic light passes through two narrow slits 0.40 mm apart the third order bright fringe of interference pattern, observed on a screen 1 meter from slit is 3.6 mm from the centre of (maximum central) what is wavelength of the light.

Ans: given $d = 0.40\,mm$, $D = 10^3\,mm$, $y = 3.6\,mm$

$m = 3$ (order)

we get $\lambda = \frac{yd}{mD} = \frac{(3.6) \times (0.40)}{3 \times 10^3}$

$= 4.8 \times 10^{-5}\,cm.$

Question No. 4. On Interference pattern with λ 6000°A, the zero order and tenth order maxima falls at 12.34 mm and 14.73 mm. Find the fringe width.

Ans $\lambda = 6000°A$, Distance between zero order and tenth order is $14.73 - 12.34 = 2.39\,mm$

So the fringe width is $\frac{2.39}{10} = 0.239\,mm$

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Question No 5:- In Double slit arrangement one of slit is covered by mica sheet whose refractive index is 1.58. the distance between two source are 0.1cm and 50 cm. Due to introduction of mica sheet, the central fringe get shifted by 0.2 cm. Determine the thickness of mica sheet.

Solution: $y_0 = 0.2\ cm$, $d = 0.1\ cm$, $D = 50\ cm$

Hence $t = \frac{d\,y_0}{D(\mu - 1)} = \frac{0.1 \times 0.2}{50 \times 0.58}$

$\mu = 1.58$

$t = 6.7 \times 10^{-4}\ cm.$

Question 6. In a Fresnel Biprism experimat the eyepiece is at a distance of 100 cm. from the ~~slit~~ slit. A convex lens inserted between the Biprism and the eyepiece gives the two images of the slit in two position. First case the distance of slit are 4.05 mm and in other case 2.10 mm apart. When we use Sodium light having wavelength 5893. Find the thickness of the fringes. (width)

Ans. Fringe width $\beta = \frac{D\lambda}{d} = \frac{D\lambda}{d}$

$d_1 = 4.05\ mm = 0.405\ cm$, $d_2 = 2.10\ mm = 0.210$

$d = \sqrt{d_1 d_2} = \sqrt{0.210 \times 0.405} = 0.292\ cm$

$D = 100\ cm$, $\lambda = 5893\ A^\circ$

$\beta = \frac{100 \times 5893 \times 10^{-8}}{} = 0.0202\ cm.$