21.WAVE OPTICS

Interference of waves of intensity I_1 and I_2 :

resultant intensity, $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\ \cos(\Delta\phi)$ where, $\Delta\phi$ = phase difference.

For Constructive Interference : $I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

For Destructive interference : $I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$

If sources are incoherent $I = I_1 + I_2$, at each point.

YDSE :

Path difference, $\Delta p = S_2P - S_1P = d \sin\theta$

if $d << D$ $= \frac{dy}{D}$

if $y << D$

for maxima, $\Delta p = n\lambda$ $y = n\beta$ $n = 0, \pm 1, \pm 2$ ....

for minima $\Delta p =$ $\Delta p = \begin{cases} (2n-1)\frac{\lambda}{2} & n = 1, 2, 3............ \\ (2n+1)\frac{\lambda}{2} & n = -1, -2, -3........ \end{cases}$

$$y = \begin{cases} (2n-1)\frac{\beta}{2} & n = 1, 2, 3............ \\ (2n+1)\frac{\beta}{2} & n = -1, -2, -3....... \end{cases}$$

where, fringe width $\beta = \frac{\lambda D}{d}$

Here, λ = wavelength in medium.

Highest order maxima : $n_{max} = \frac{d}{\lambda}$

total number of maxima = $2n_{max} + 1$

Highest order minima : $n_{max} = \frac{d}{\lambda} + \frac{1}{2}$

total number of minima = $2n_{max}$.

Intensity on screen : $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\ \cos(\Delta\phi)$ where, $\Delta\phi = \frac{2\pi}{\lambda}\Delta p$

If $I_1 = I_2$, $I = 4I_1 \cos^2 \frac{\Delta\phi}{2}$

YDSE with two wavelengths λ_1 & λ_2 :

The nearest point to central maxima where the bright fringes coincide:

$y = n_1\beta_1 = n_2\beta_2$ = Lcm of β_1 and β_2

The nearest point to central maxima where the two dark fringes coincide,

$y = (n_1 - \frac{1}{2})\beta_1 = n_2 - \frac{1}{2})\beta_2$

Optical path difference

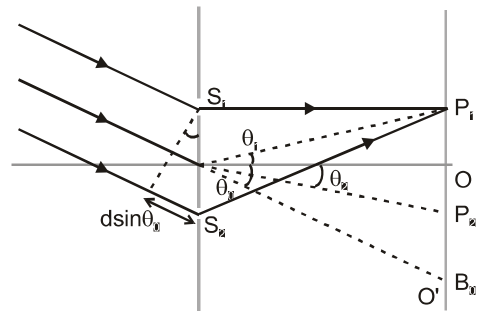
$$\Delta p_{opt} = \mu \Delta p$$

$$\Delta\phi = \frac{2\pi}{\lambda}\ \Delta p = \frac{2\pi}{\lambda_{vacuum}}\ \Delta p_{opt}$$

$$\Delta = (\mu - 1)\ t.\ \frac{D}{d} = (\mu - 1)t\ \frac{B}{\lambda}.$$

YDSE WITH OBLIQUE INCIDENCE

In YDSE, ray is incident on the slit at an inclination of θ_0 to the axis of symmetry of the experimental set-up



We obtain central maxima at a point where, $\Delta p = 0$.

or $\theta = \theta_0$.

This corresponds to the point O in the diagram.

Hence we have path difference.

$$\Delta p = \begin{cases} d(\sin\theta_0 + \sin\theta) - \text{for points above O} \\ d(\sin\theta_0 - \sin\theta) - \text{for points between O \& O'} \\ d(\sin\theta - \sin\theta_0) - \text{for points below O'} \end{cases} \qquad \text{... (8.1)}$$

THIN-FILM INTERFERENCE

for interference in reflected light $2\mu d = \begin{cases} n\lambda & \text{for destructive interference} \\ (n + \frac{1}{2})\lambda & \text{for constructive interference} \end{cases}$

for interference in transmitted light $2\mu d = \begin{cases} n\lambda & \text{for constructive interference} \\ (n + \frac{1}{2})\lambda & \text{for destructive interference} \end{cases}$