Previous Year Question with Solution :

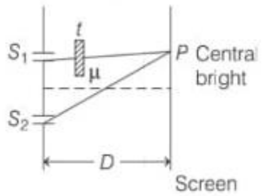
In a double slit experiment, when a thin film of thickness t having refractive index μ is introduced in front of one of the slits, the maximum at the centre of the fringe pattern shifts by one fringe width. The value of t is (λ is the wavelength of the light used) **(2019 Main, 12 April I)**

(a) $\frac{2\lambda}{(\mu-1)}$ (b) $\frac{\lambda}{2(\mu-1)}$ (c) $\frac{\lambda}{(\mu-1)}$ (d) $\frac{\lambda}{(2\mu-1)}$

2 As we know,

Path difference introduced by thin film,

$$\Delta = (\mu - 1)t \quad \text{...(i)}$$



and if fringe pattern shifts by one frings width, then path difference,

$$\Delta = 1 \times \lambda = \lambda \quad \text{...(ii)}$$

So, from Eqs. (i) and (ii), we get

$$(\mu - 1)t = \lambda \Rightarrow t = \frac{\lambda}{\mu - 1}$$

Alternate Solution

Path difference introduced by the thin film of thickness t and refractive index μ is given by

$$\Delta = (\mu - 1)t$$

∴ Position of the fringe is

$$x = \frac{\Delta D}{d} = \frac{(\mu - 1)tD}{d} \quad \text{...(i)}$$

Fringe width of one fringe is given by

$$\beta = \frac{\lambda D}{d} \quad \text{...(ii)}$$

Given that $x = \beta$, so from Eqs. (i) and (ii), we get

$$\Rightarrow \quad \frac{(\mu - 1)\,tD}{d} = \frac{\lambda D}{d}$$

$$\Rightarrow \quad (\mu - 1)t = \lambda \ \text{ or } t = \frac{\lambda}{(\mu - 1)}$$