Interference in Wedge Shaped thin film

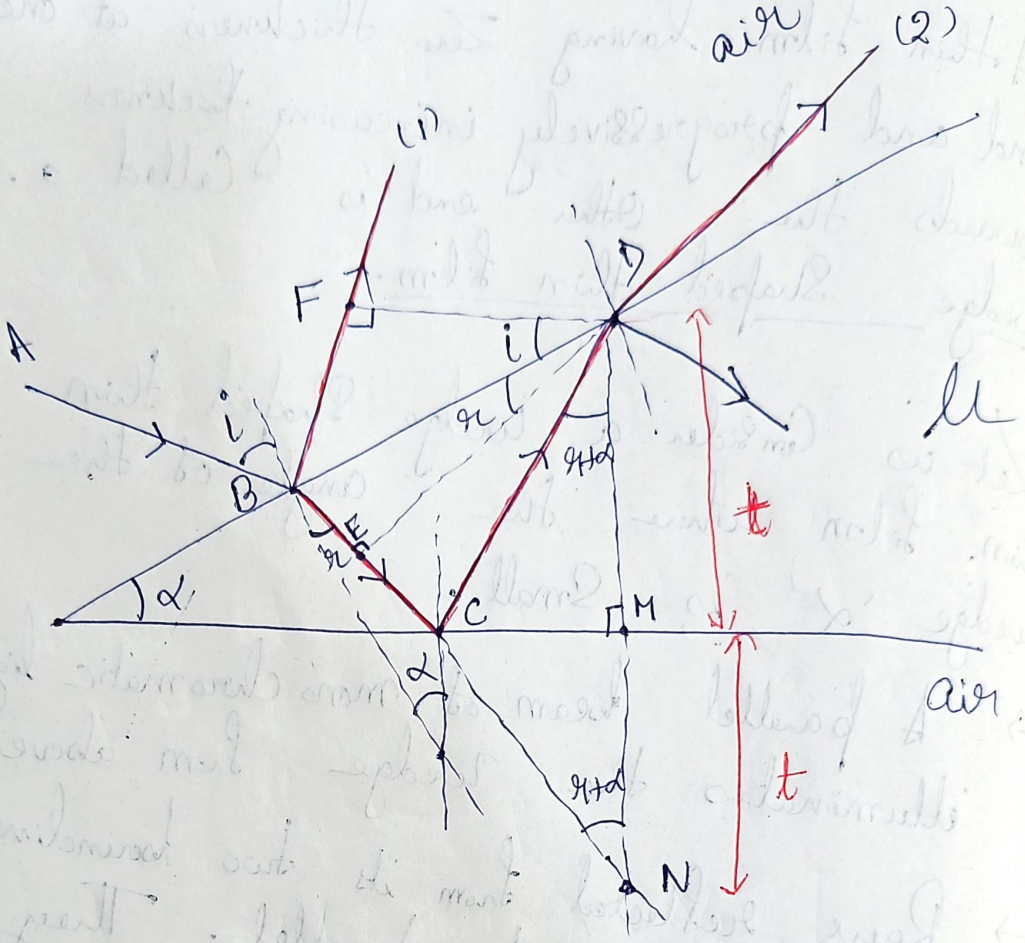
A thin film having Zero thickness at one end and progressively increasing thickness towards the other end is called a. wedge Shaped thin film.

→ Let us Consider a wedge Shaped thin thin film where the angle of the wedge 'α' is Small.

→ A parallel beam of mono chromatic light illuminates the wedge from above.

→ Rays reflected from its two bounding Surfaces will not be parallel. They appear to diverge from a point near the film.

→ Path difference between the rays reflected from the top and bottom of the air film varies along its length due to variation in film thickness.



→ When light "AB" is incident on the film a part of it is reflected as Ray (1) and the other part is refracted as 'BC'.

→ At the point C, again a ray of light is reflected as CD and emerges into air as Ray (2).

→ As we are observing the film from the

Top, we will Consider the path difference between Ray (1) and Ray (2).

→ Rays (1) & (2) are in a Condition to interfere as they originate from the same initial ray AB.

The path difference between the rays (1) & (2) is

~~$\Delta = \mu(CD+$~~

$$\Delta = \mu(BC+CD) - BF \quad \text{——} (1)$$

Now,

$$\mu = \frac{\sin i}{\sin r} = \frac{BF/BD}{BE/BD}$$

$$\Rightarrow \boxed{BF = \mu BE} \quad \text{——} (2)$$

Substitute eqn (2) in (1),

$$\Delta = \mu(BC+CD) - \mu BE$$

$$= \mu(BE+EC+CD) - \mu BE$$

$$= \mu(EC+CD) = \mu(EC+CN)$$

$(\because CD = CN)$

$$= \mu EN \quad \text{——} (3)$$

In ΔEDN,

$$EN = DN \cos(\theta + \alpha)$$

$$= 2DM \cos(\theta + \alpha)$$

$$= 2t \cos(\theta + \alpha) \quad \text{---(4)}$$

Substitute eq^n (4) in eq^n (3)

$$\Delta = 2\mu t \cos(\theta + \alpha) \quad \text{---(5)}$$

Due to reflection, an addition path difference of $\lambda/2$ is introduced at the point 'B' in the path of Ray(1)

So the effective path difference

$$\boxed{\Delta = 2\mu t \cos(\theta + \alpha) - \lambda/2} \quad \text{---(6)}$$

Condition for minima

$$\Delta = (2n+1)\lambda/2, \quad n = 0, 1, 2, 3 \ldots$$

$$\Rightarrow 2\mu t \cos(\theta + \alpha) - \lambda/2 = (2n+1)\lambda/2$$

$$\Rightarrow \boxed{2\mu t \cos(\theta + \alpha) = n\lambda} \quad n = 0, 1, 2, \ldots$$

Condition for maxima.

$$\Delta = n\lambda, \quad n = 0, 1, 2, \ldots$$

$$\Rightarrow 2\mu t \cos(\theta_t + \alpha) - \lambda/2 = n\lambda.$$

$$\Rightarrow \boxed{2\mu t \cos(\theta_t + \alpha) = (2n+1)\lambda/2}$$

$n = 0, 1, 2, 3 \ldots$