Coherent Sources :-

कलाग्रबद्ध स्रोत Two sources are said to be Coherent if they emit a light waves of the same frequency and nearly the same amplitude and are always in phase with each other.

This means that the two ~~waves~~ sources must emit radiations of the same colour (wavelength).

Since the wavelength of light is extremely small and it is of the order of 10^{-5} cm, two sources must be narrow and must also be close to each other.

For max^m intensity :- occurs when the phase difference between the two waves reaching the point is a whole number multiple of 2π or path difference between the two waves is a whole number multiple of wavelength.

Minimum intensity :-

(Minimum intensity at a point when the phase difference between the two waves reaching the point ~~occu~~ is an odd number multiple of π or the path difference between the two waves is an odd number multiple of half wavelength

Phase difference and path difference:-
(कलान्तर) (पथान्तर)

If the path difference between the two waves is λ the phase difference $= 2\pi$

Suppose for a path difference x, the phase diff is δ.

For a path difference λ, the phase difference $= 2\pi$

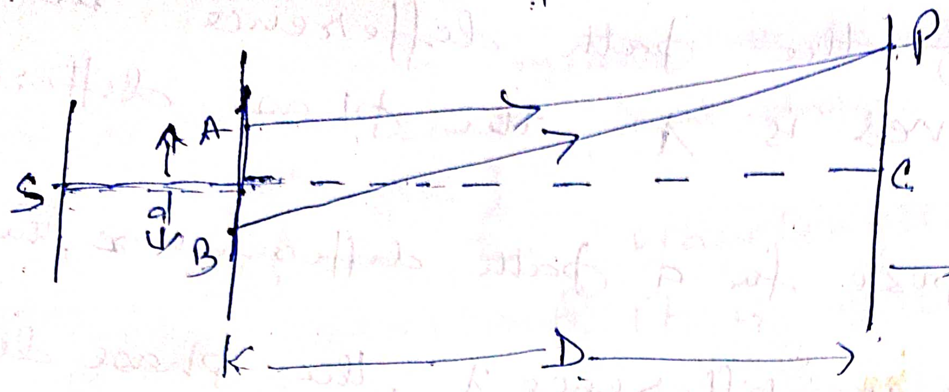
$\therefore$ For a path difference x, the phase diff $= \frac{2\pi x}{\lambda}$

$$\text{Phase difference, } \delta = \frac{2\pi x}{\lambda}$$

$$= \frac{2\pi}{\lambda} \times \text{Path difference}$$

Analytical treatment of interference:-
~~(Principle of superpositions)~~

Let us consider a monochromatic source of light S emitting waves of wavelength λ and two narrow pinholes A & B. A & B are equidistant from S and act as two virtual coherent sources.



Let a be the amplitude of the wave and δ is the phase difference between two waves reaching the point P.

If y_1 & y_2 are the displacement

then $y_1 = a \sin \omega t$

and $y_2 = a \sin(\omega t + \delta)$

$\therefore$ Resultant displacement

$$y = y_1 + y_2$$

$$= a \sin \omega t + a \sin(\omega t + \delta)$$

$$= a \sin \omega t + a(\sin \omega t . \cos \delta + \cos \omega t . \sin \delta)$$

$$= a \sin \omega t + a \sin \omega t \cos \delta + a \cos \omega t . \sin \delta,$$

$$= a \sin \omega t (1 + \cos \delta) + a \cos \omega t . \sin \delta$$

$) + \cos A . \sin B$

Now taking,

$$a(1+\cos\delta) = R\cos\theta \quad \text{---} (i)$$

and $$a\sin\delta = R\sin\theta \quad \text{---} (ii)$$

Then $y = R\sin\omega t\cos\theta + R\cos\omega t \cdot \sin\theta$

$= R(\sin\omega t\cos\theta + \cos\omega t\cdot\sin\theta)$

or, $$y = R\sin(\omega t+\theta) \quad \text{---} (iii)$$

This represents the equation of simple harmonic vibration of amplitude R.

Now squaring eqn (i) & (ii) and adding, we get

$$R^2\cos^2\theta + R^2\sin^2\theta = a^2(1+\cos\delta)^2 + a^2\sin^2\delta$$

or $R^2(\sin^2\theta+\cos^2\theta) = a^2(1+2\cos\delta+\cos^2\delta) + a^2\sin^2\delta$

$\sin^2\theta+\cos^2\theta = 1$

or $R^2 = a^2(1+2\cos\delta+\underline{\sin^2\delta+\cos^2\delta})$

$= a^2(1+2\cos\delta+1)$

$= a^2(2+2\cos\delta)$

$= 2a^2(1+\cos\delta)$.

or, $$R^2 = 2a^2\, 2\cos^2\frac{\delta}{2} = 4a^2\cos^2\frac{\delta}{2}$$

or, $R^2 = 4a^2 \cos^2 \frac{\delta}{2}$

The intensity at a point is given by the square of the amplitude

$I = R^2$

or $\boxed{I = 4a^2 \cos^2 \frac{\delta}{2}}$ —— (IV)