Various forms of Antenna Arrays:-

Various antenna arrays used in practice are the following :-

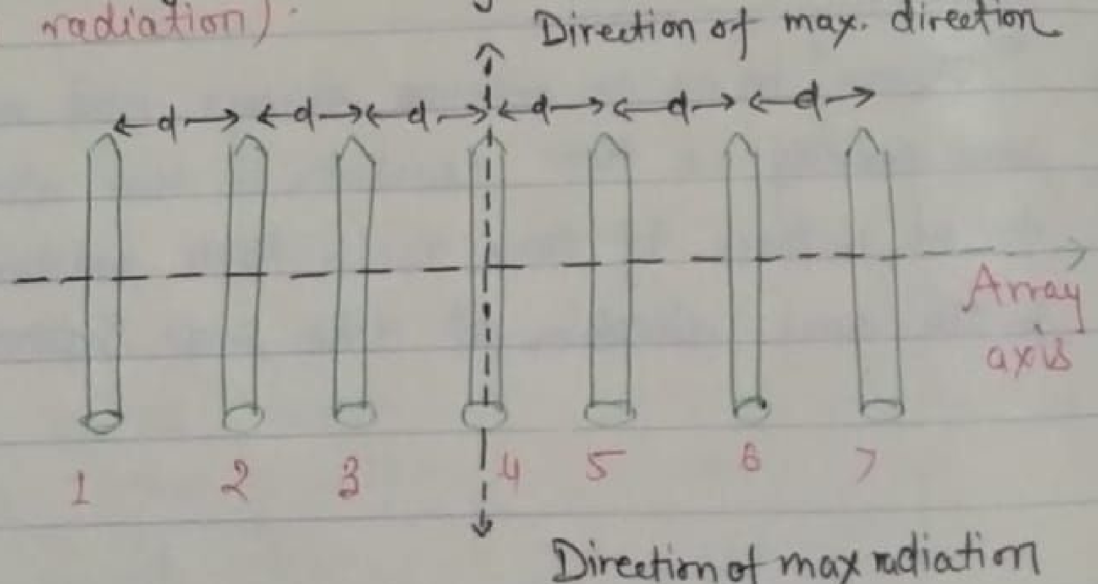
1. Broadside Array
2. Endfire Array
3. Colinear Array
4. Parasitic Array.

1. Broadside Array

This is one of the important antenna arrays used in practice. Broadside array is one in which a number of identical parallel antennas are set up along a line drawn perpendicular to their respective axes.

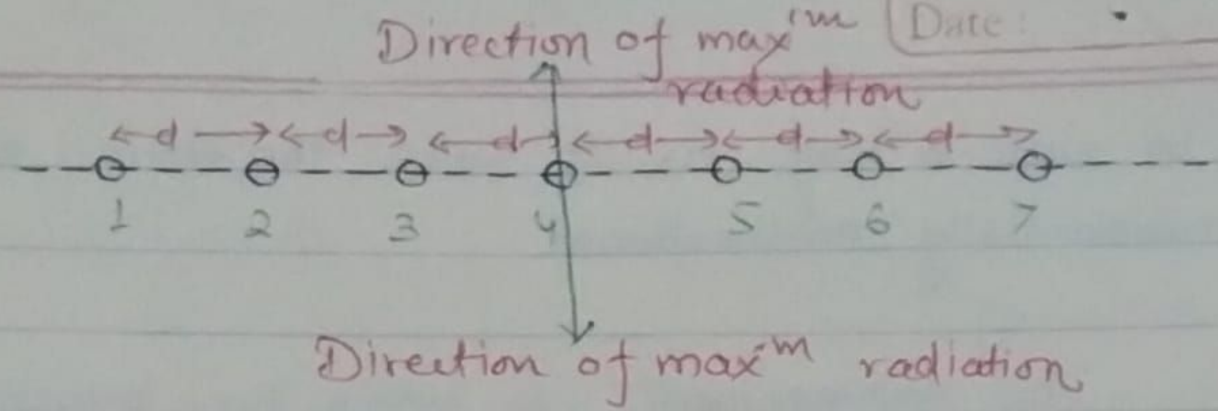
In the broadside array all the antenna are in the same phase. The broadside array is bidirectional which radiates equally well in either direction of maximum radiations.

The broadside array may be defined as An arrangement in which the principal direction radiation is perpendicular to the array axis and also to the plane containing the array element. (Direction of maximum radiation).

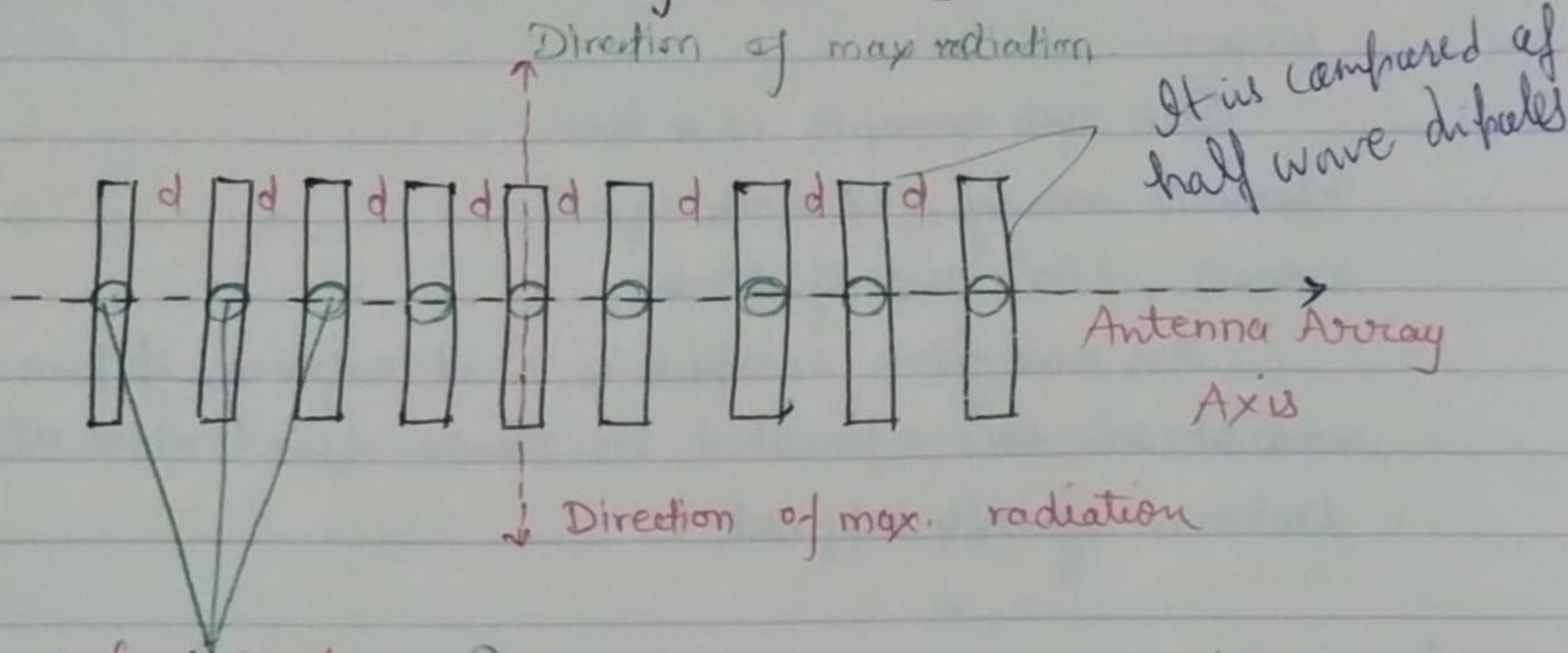


Broadside Array Arrangement

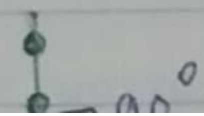
Date :



ⓐ Front view of the array



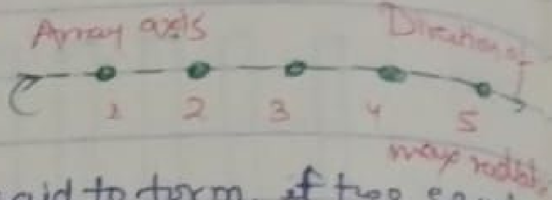
ⓑ Top view of the Broad side array.



in such a way as to make the entire arrangement substantially anidirectional.

The arrangement in which the principal direction of radiation coincides with the direction of the array axis.

One such example is a two elements array, fed with equal current, 180° out of phase.



An end fire couplet is said to form, if two equal radiations are operated in phase quadrature at a distance of $\lambda/4$ apart.

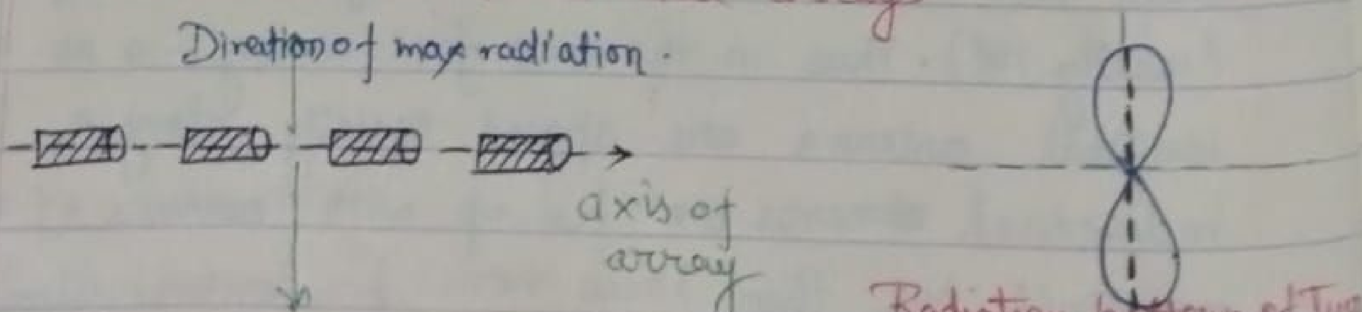
X

3. Colinear Array

In this type of array, the antennas are arranged co-axially i.e antennas are mounted end to end in a single line.

The individual elements are fed with equal in phase currents as in the case of broadside arrays. A colinear array is a broadside radiators, in which the direction of maximum radiation is perpendicular to the line of antenna.

A colinear array is also sometimes called as broadcast or omnidirectional arrays



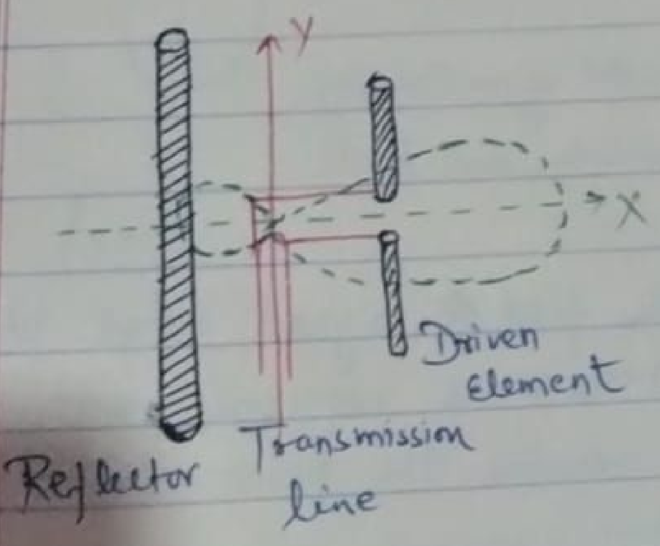
Radiation pattern of Two
4. horizontal antennas arranged colinearly. colinear array

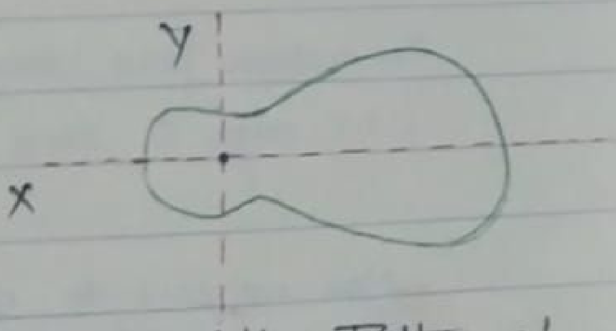
More than four elements in the array is generally not used as more gain can be obtained by some otherwise device but two elements colinear array is usually used because it helps in multiband operation. Two elements colinear array is also known as Two half-waves in phase.

4. Parasitic Array.

In order to reduce the problem of fed line, it is, some one time desirable to feed certain antennas of an array parasitically. The element supplied power directly from source through transmission line is called as driven element, parasitic element is not feed directly, instead of parasitic elements drive power by radiation from near by driven elements. Multielement arrays having number of parasitic element are called Parasitic Array. wheather driven element is one or more. Hence in parasitic arrays there is one or more parasitic element and atleast one driven element to introduce power in the array.

A parasitic array with linear half-wave dipole as element is called as Yagi-Uda. (VHF & UHF) 80MHz to 800MHz.



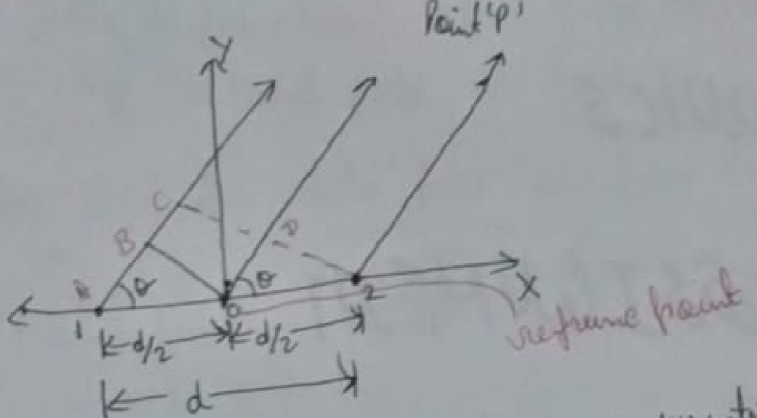


Radiation Pattern of Parasitic array.

Array of two point Source →

① Equal Amplitude and phase ② Equal Amplitude and opposite phase
③ unequal Amplitude and opposite phase.

① Array of two point sources with equal amplitude and phase →



Let us consider two isotropic point sources symmetrically situated w.r. to origin Which is shown in above fig Let us conside point 'O' is origin point, as refrence point for phase calculation.
from the fig it is clear wave from point 1 reach P at latter time than the waves from point 2 source.

Path difference b/w two waves is given by →

$$\text{Path difference} = AC = \frac{d}{2}\cos\theta + \frac{d}{2}\cos\theta$$
$$= d\cos\theta \text{ meters}$$
$$= \frac{d\cos\theta}{\lambda} \text{ wave length}$$

$\psi = \frac{\psi}{2} (\psi) = \psi$

from optics phase angle is given by ⇒

$\psi \rightarrow$ phase difference b/w the two fields of the two waves measured w.r.t. origin

$$\psi = 2\pi(\text{Path difference})$$
$$\boxed{\psi = 2\pi \times \frac{d}{\lambda}\cos\theta \text{ rad}}$$

Here $\alpha = 0$

$$\boxed{\psi = \frac{2\pi d}{\lambda}\cos\theta + \alpha}$$

we know that $\beta = \frac{2\pi}{\lambda}$

So $\boxed{\psi = \beta d \cos\theta}$

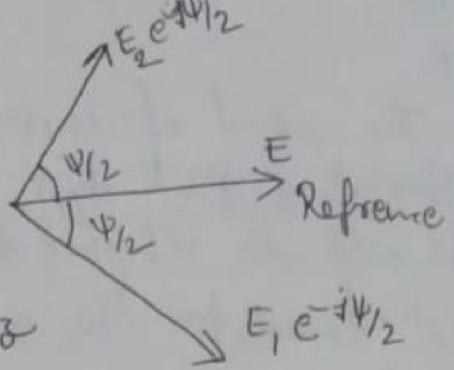
Let E_1 is far electric field at P due to source (1)

E_2 is far electric field at P due to source (2)

$E \Rightarrow$ Total field at point P.

Then total far electric field at point P $\rightarrow$

$$\boxed{E = E_1 e^{-j\psi/2} + E_2 e^{j\psi/2}} \rightarrow (1)$$



Where $E_1 e^{-j\psi/2} \Rightarrow$ field component due to source (1) so it has term $e^{-j\psi/2}$ becoz field is lags.

$E_2 e^{j\psi/2} \Rightarrow$ " " " (2) so " $e^{j\psi/2}$ becoz field leads.

But $E_1 = E_2 = E_0$.

So from eqn (1) we get

$$E = E_0 \left(e^{-j\psi/2} + e^{j\psi/2}\right)$$

$$E = 2E_0 \left(\frac{e^{-j\psi/2} + e^{j\psi/2}}{2}\right)$$

$$\boxed{E = 2E_0 \cos\psi/2} \rightarrow (2)$$

$$\boxed{E = 2E_0 \cos\left(\frac{\beta d \cos\theta}{2}\right)} \rightarrow (3)$$

Normalized field $\rightarrow$

$$E_{norm} = \frac{E}{|E|} = \frac{\cancel{2E_0} \cos\left(\frac{\beta d \cos\theta}{2}\right)}{\cancel{2E_0}}$$

$$E_{norm} = \cos\left(\frac{\beta d \cos\theta}{2}\right)$$

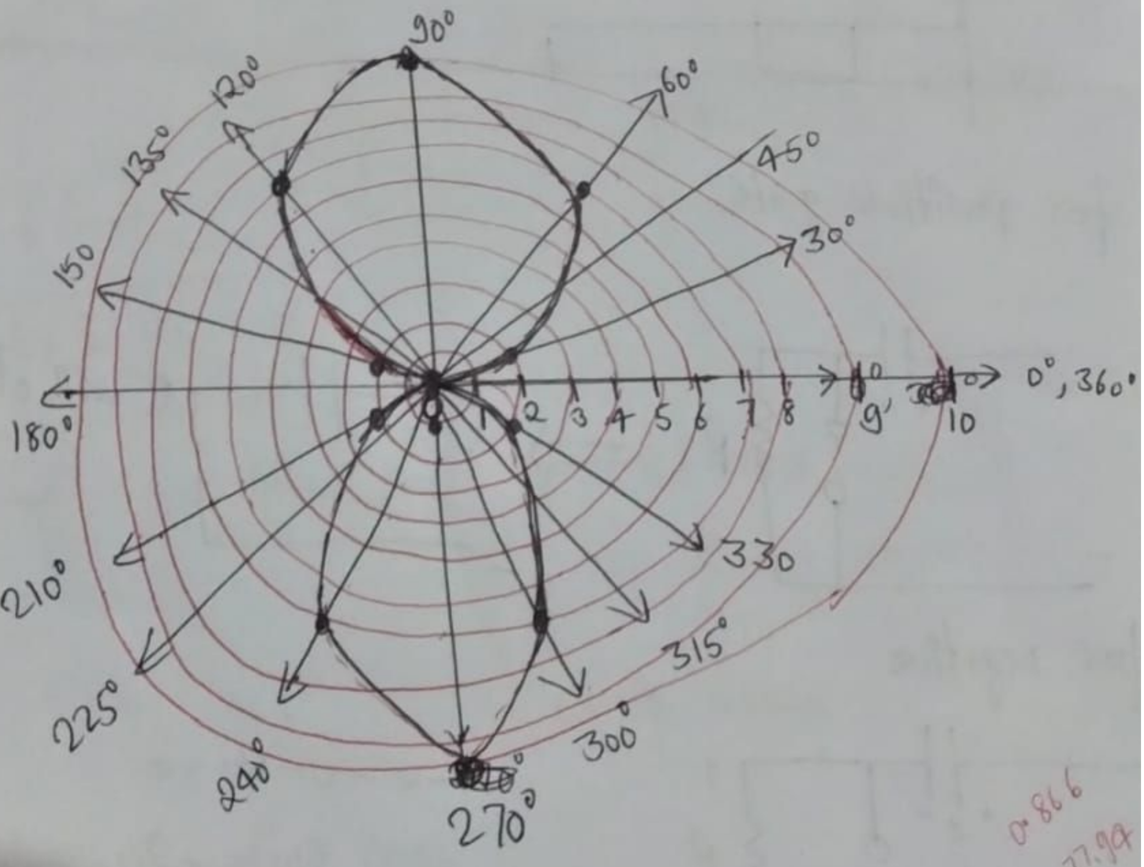
$$E_{norm} = \cos\left\{\frac{2\pi}{\lambda} \times \frac{\lambda}{2} \times \frac{1}{2} \cos\theta\right\}$$

put $d = \lambda/2$

$\beta = \frac{2\pi}{\lambda}$

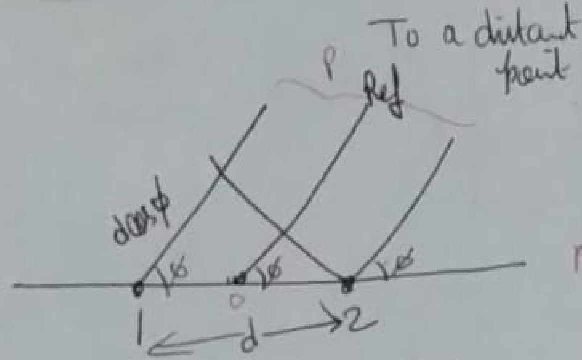
$$\boxed{E_{norm} = \cos\left(\frac{\pi}{2}\cos\theta\right)} \rightarrow (4)$$

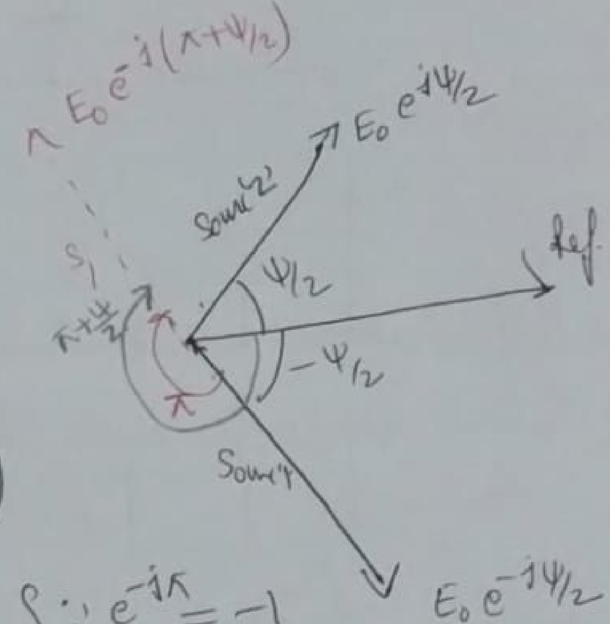
θ°	0	30	60	90	120	150	180	210	240	270	300	330
E_{norm}	0	0.2	0.707	1	0.707	0.2	0	0.2	0.707	1	0.707	0.2



0.866
77.94

Case IInd, Same Amplitude but opposite phase





Total electric field at point 'P'

$$E = E_0 e^{j\psi/2} + E_0 e^{-j(\pi+\frac{\psi}{2})}$$

$$= E_0 e^{j\psi/2} + E_0 (e^{-j\pi} \times e^{-j\psi/2})$$

$$= E_0 \{ e^{j\psi/2} - e^{-j\psi/2} \} \quad \{ \because e^{-j\pi} = -1$$

$$= 2jE_0 \left\{ \frac{e^{j\psi/2} - e^{-j\psi/2}}{2j} \right\}$$

$$\boxed{E = 2jE_0 \sin(\psi/2)}$$

~~We know w~~ we know that $\psi = \beta d \cos\phi$

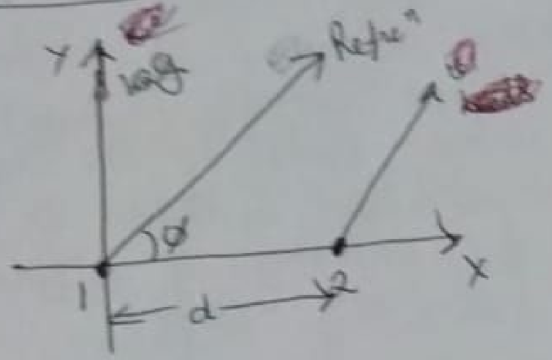
$$= \frac{2\pi}{\lambda} \times \frac{\lambda}{2} \cos\phi$$

$$\psi = \pi\cos\phi$$

$$E = 2jE_0 \sin\left[\frac{\pi}{2}\cos\phi\right]$$

$$\boxed{E_{norm} = \sin\left(\frac{\pi}{2}\cos\phi\right)}$$

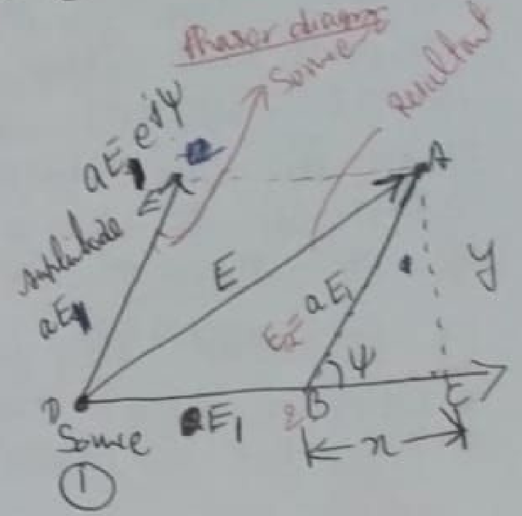
(3) Two isotropic point sources of unequal Amplitude and any phase difference →



Let us consider Source (1) as reference for phase and amplitude of fields due to source (1) & source (2) at a distance P is E_1 and E_2 in which $E_1 > E_2$.

Here we take $E_2 = aE_1$

where $a \leq 1$ — scaling factor



In ΔABC →

$$\cos\psi = \frac{x}{aE_1}$$

$$\boxed{x = aE_1 \cos\psi}$$

$$\sin\psi = \frac{y}{aE_1}$$

$$\boxed{y = aE_1 \sin\psi}$$

$$DC = BD + BC$$

$$= E_1 + aE_1 \cos\psi$$

$$= E_1 (1 + a\cos\psi)$$

In $\Delta ADC \rightarrow$

$$AD^2 = DC^2 + AC^2$$

$$AD^2 = (E_1 + x)^2 + y^2$$

$$AD^2 = (E_1 + aE_1\cos\psi)^2 + (aE_1\sin\psi)^2$$

$$AD^2 = E_1^2\{(1 + a\cos\psi)^2 + a^2\sin^2\psi\}$$

$$\boxed{E = E_1\sqrt{(1 + a\cos\psi)^2 + (a\sin\psi)^2}}$$

$\tan\phi = y/x$

$$\tan\phi = \frac{aE_1\sin\psi}{E_1 + aE_1\cos\psi} = \frac{a\sin\psi}{1 + a\cos\psi}$$

$$\boxed{\tan\phi = \frac{a\sin\psi}{1 + a\cos\psi}}$$