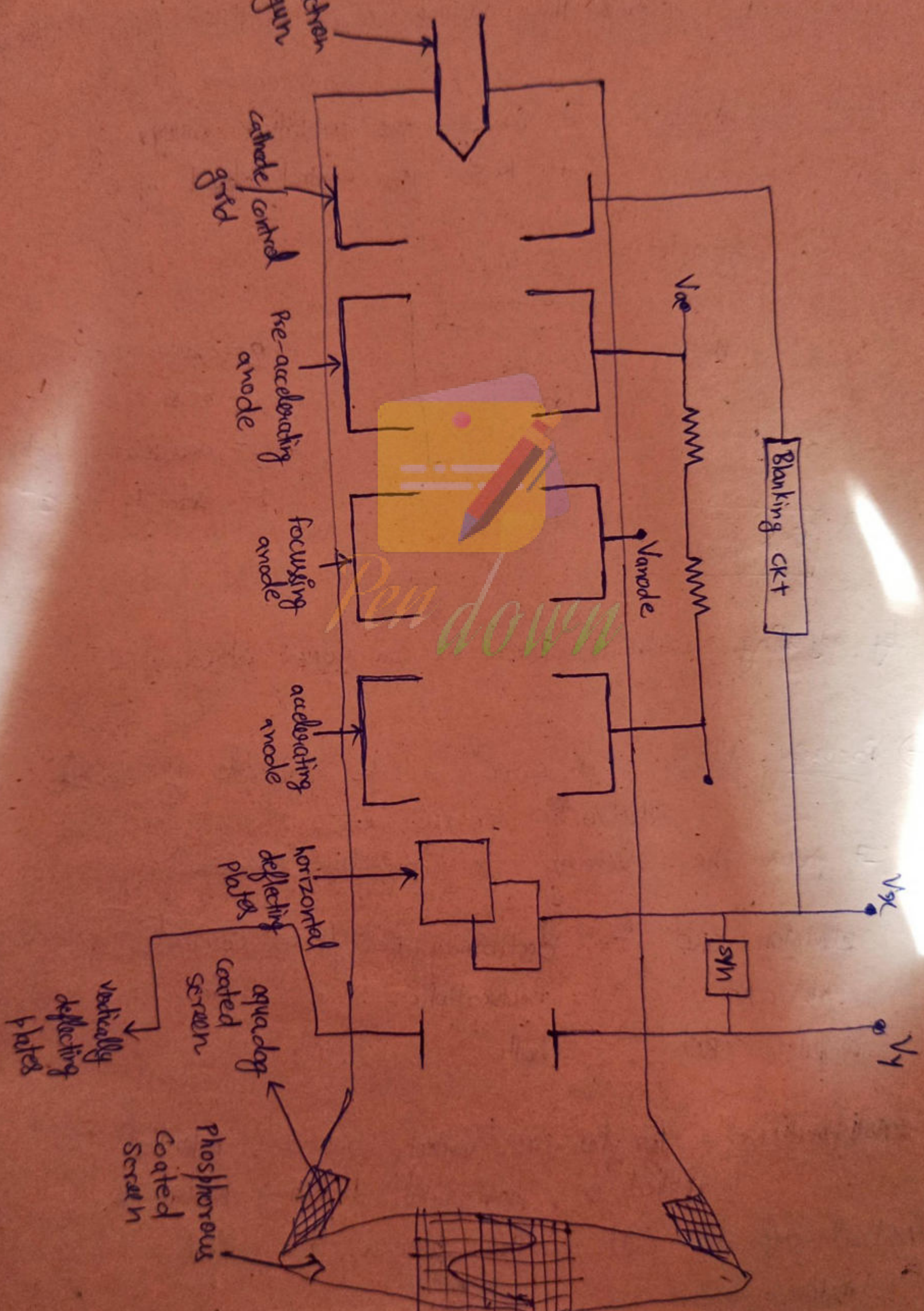
CRO


electron gun
cathode/control grid
Pre-accelerating anode
focussing anode
accelerating anode
horizontal deflecting plates
vertically deflecting plates
aquadag coated screen
Phosphorous Coated Screen
Blanking ckt
Va
Vanode
Vx
Vy
syn

Parts :-

① **Electron Gun** :- It emits e^- in cathode Ray Tube by Thermionic emission

② **Control grid** :- controls the no. of e^-s emitted from cathode

③ **Accelerating Anode** :- It Converts the potential energy of e^- into K.E to control speed of e^-.

$$\frac{1}{2} m v^2 = q \cdot V_{acc}$$

$$\boxed{v = \sqrt{\frac{2q \cdot V_{acc}}{m}}}$$

q = charge of e^-
m = mass of e^-
V_{acc} = accelerating potential
v = velocity of e^-

$$\boxed{v \propto \sqrt{V_{acc}}}$$

by adjusting accelerating pot we can adjust speed of e^-

④ **Focussing Anode** : It works on the principle of double electron concave lens.

It focus the electrons in particular direction.

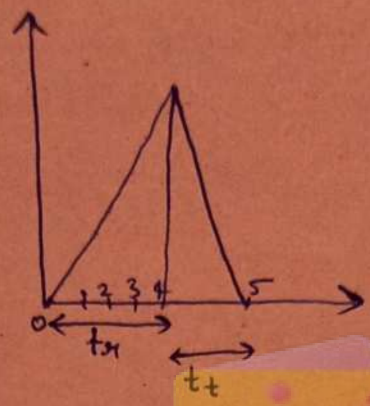
Television CRO	=	electromagnetic focus control
Lab. CRO	=	electrostatic " "
Computer CRO	=	both

* **Astigmatism** :- for fine focus control, small DC potential is applied on horizontal deflecting plate & vertical deflecting plate : This process is called Astigmatism.

(5) Harizontal Deflection Plate:

(a) kept vertically to ~~se~~ shift the electron beam horizontally

(b) A sawtooth or sweep signal is applied to horizontal plate



Sweep signal
(produced by UJT or op-amp)

(c) To get waveform on screen, the time period of saw tooth signal = ~~test~~ time period of test signal of vertical deflection plate

(6) Vertical deflection plate:

(a) Kept horizontal to shift e^- beam vertically

(b) Test signals are applied to VDP.

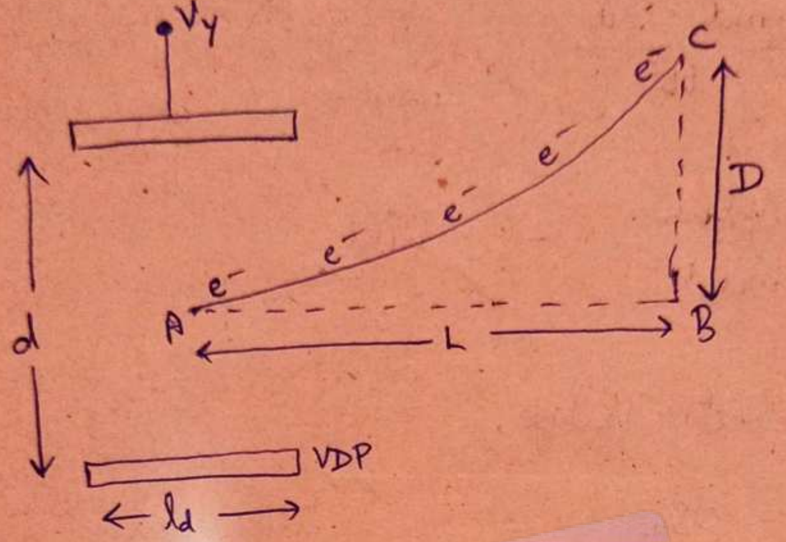
(7) Phosphorous Coated screen:

when e^- travelling cathode Ray tube they posses K.E and on strike to screen, KE converted to heat energy which is absorbed by phosphorous molecules and they convert it into light energy

(8) Aquadag Coated screen:

secondary e^- are those e^- which are reflected back from the phosphorous coated screen. Aquadag Graphite coating collect them to maintain electron neutrality in CRT

Deflection sensitivity:



D = def. in screen

l_d = length of VDP

L = dist. b/w^n centre of VDP & screen

d = dist b/w^n VDPs

V_a = anode potential

V_y = Pot of VDP.

$$\boxed{D = \frac{L\, l_d\, V_y}{2 V_a d}} \quad (v/m)$$

Proof:-

acceleration along y-axis is -

$$a_y = \frac{F}{m} = \frac{eE}{m} = \frac{eV}{md}$$

then velocity along y-axis -

$$v_y = 0 + a_y t$$

$$\boxed{v_y = \frac{eV}{md} \times \frac{l}{u}} \quad ---(i)$$

Now considering ΔABC

$$\frac{D}{L} = \frac{v_y}{v_x}$$

from equ^n (i)

$$\frac{D}{L} = \frac{\frac{eV_y}{md} \cdot \frac{l_d}{u}}{u}$$

so $$D = \frac{eV_y l_d L}{md\,u^2} \quad \text{---} (ii)$$

Let V_a be accelerating voltage,

$$\frac{1}{2} m u^2 = eV_a$$

$$u^2 = \frac{2eV_a}{m}$$

in equ^n (ii)

$$D = \frac{eV_y l_d L\, m}{md \cdot 2eV_a}$$

$$D = \frac{\cancel{e} V_y l_d L}{2\cancel{e} V_a d}$$

$$\boxed{D = \frac{L l_d V_y}{2V_a d}} \quad (\text{Unit} = V/m)$$

$$\text{sensitivity} = \frac{D}{V_y}$$

$$\boxed{\text{sensitivity} = \frac{L l_d}{2V_a d}}$$

unit = (m/V)

$$\boxed{\text{Deflection} \propto \text{deflection of voltage } V_y}$$

Basic of CRO

(1) CRO = Cathode Ray oscilloscope

(2) CRO has 4 Sections → (1) display
(2) vertical controller
(3) horizontal "
(4) Triggers

(3) Properties can be analyzed are –
(1) Amplitude
(2) frequency
(3) Rise time
(4) Distortion
(5) Time interval

(4) <u>working</u> :- (1) CRT produce e^- beam accelerated to a high velocity.

(2) CRT also act as heating element

(3) ~~[illegible]~~ & then e^- brings to focal point of ~~[illegible]~~ fluorescent screen. & got visible

(5) (1) low voltage is used for heater of e^- gun to generate e^- beam

(2) high voltage is required for CRT to speed up the beam.

Components of CRT (Cathode Ray Tube)

① Electron Gun Assembly
② Deflection Gun "
③ Flourescent Gun "
④ Glass Envelope and Base of tube

---

① Electron Gun:

ⓐ e^- are emitted, Converted to short beam and focussed on florescent screen

ⓑ It Consists a heated Cathode, a control grid, accelerating anode and a focusing anode.

ⓒ accelerated e^- beam passes through the fine hole

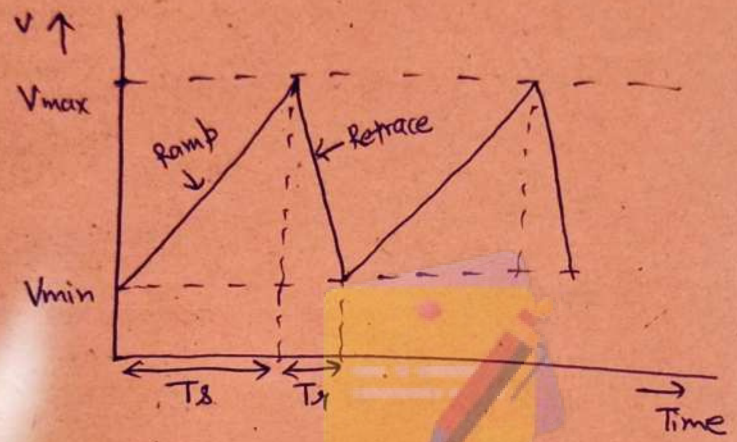
ⓓ The -ve voltage of the Control grid controls the flow of electrons so brightness of spot on CRO screen is controlled

② Horizontal deflecting system :- ⓐ Basic sweep generator

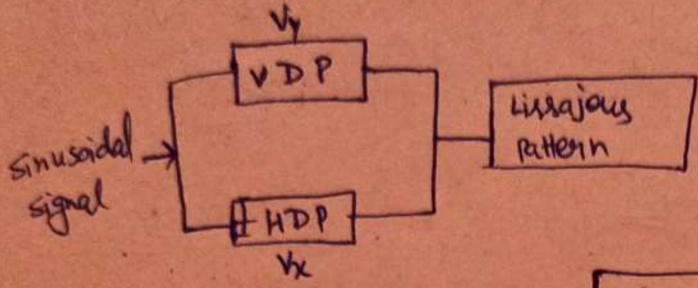
ⓑ UJT sweep "

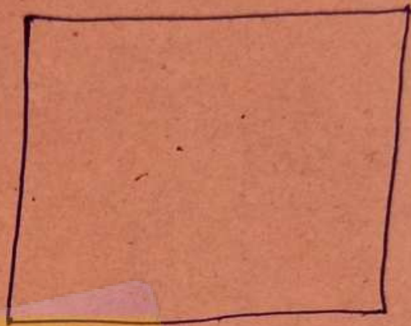
ⓒ Triggered sweep "

ⓐ Basic sweep Generator :



"Lissajous Pattern"





$V_x = V_m \sin \omega t$

$V_y = V_m \sin(\omega t + \theta)$

① Lissajous pattern will vary as per θ

② CRO will give vector addition result as output

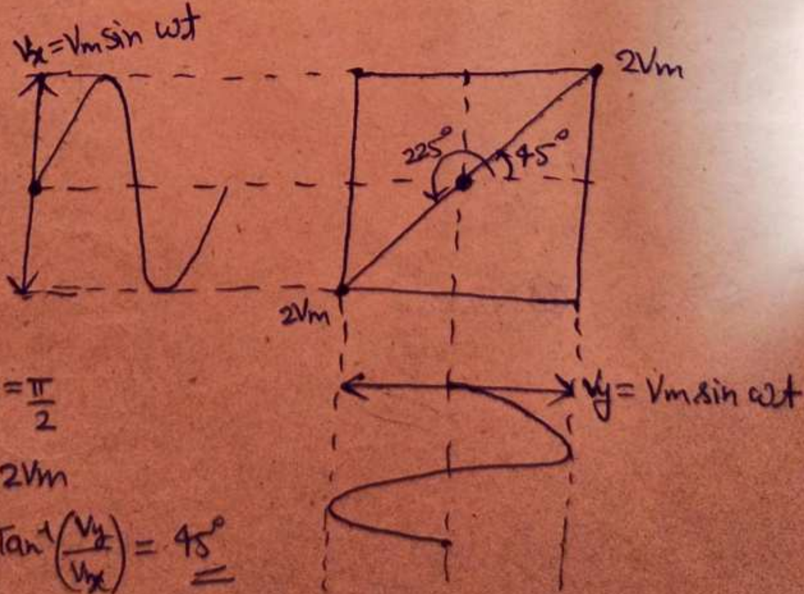
$$\boxed{V_R = \sqrt{V_x^2 + V_y^2 + 2V_x V_y \cos\theta}}$$

① At $\theta = 0^\circ$

$V_x = V_m \sin \omega t$

$V_y = V_m \sin \omega t$

$V_R = \sqrt{V_x^2 + V_y^2 + 2V_x V_y}$



at $\omega t = 0$, $V_R = 0$

at $\omega t = \frac{\pi}{2}$

$V_R = 2V_m$

$\phi = \tan^{-1}\left(\frac{V_y}{V_x}\right) = 45^\circ$

at $\omega t = \frac{3\pi}{2}$

$V_x = -V_m$

$V_y = -V_m$

$V_R = 2V_m$

$\phi = \tan^{-1}\left(\frac{-V_m}{-V_m}\right) = 225^\circ$

at $\omega t = 2\pi$

$V_x = 0$

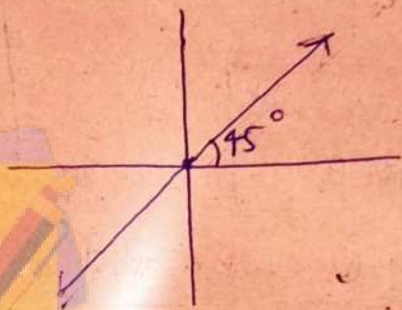
$V_y = 0$

$\boxed{V_R = 0}$

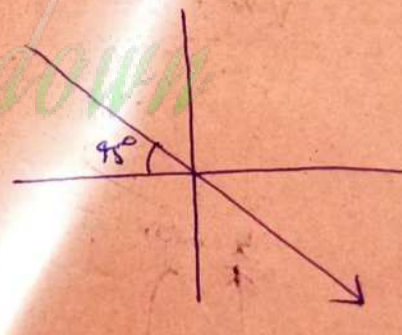
$\boxed{\phi = 0^\circ}$

---

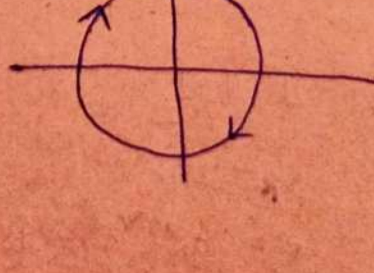
① $\theta = 0^\circ$ or 360°



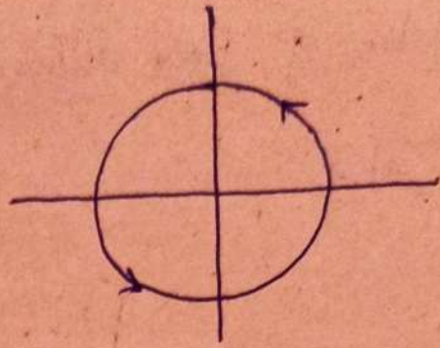
② $\theta = 180^\circ$



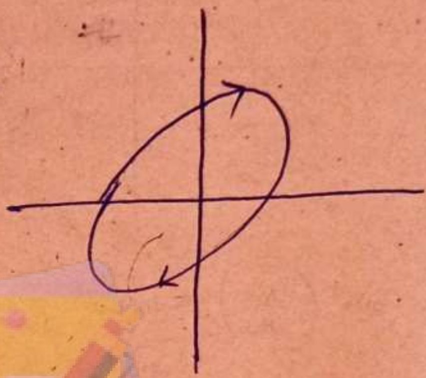
③ $\theta = 90^\circ$ (clockwise circle)



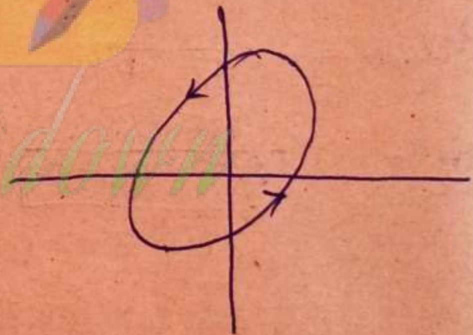
(4) $\theta = 270^\circ$ (Anticlockwise circle)



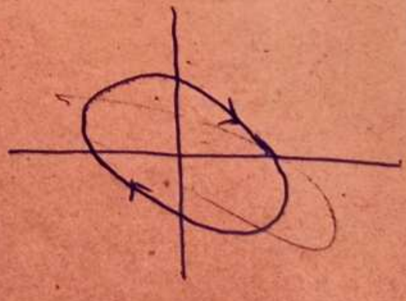
(5) $\theta = 0$ to 90° (clockwise ellipse)



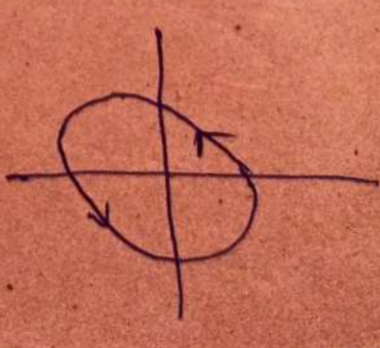
(6) $\theta = 270^\circ$ to 360° (Anticlockwise ellipse)



(7) $\theta = 90^\circ$ to 180° (clockwise ellipse)

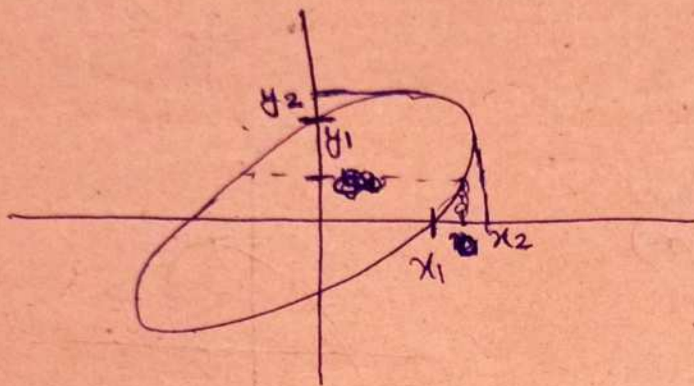


(8) $\theta = 180^\circ$ to 270° (Anticlockwise ellipse)



Calculation of phase difference using L-Pattern : b/w^n V_x & V_y

① If ellipse lie in Ist & 3rd quadrant

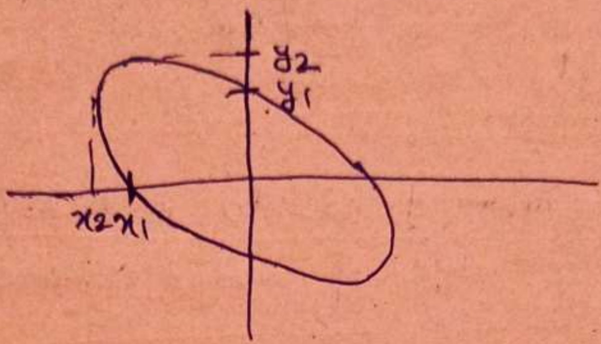


$$\phi = \sin^{-1}\left(\frac{x_1}{x_2}\right) = \sin^{-1}\left(\frac{y_1}{y_2}\right)$$

for clockwise → $\boxed{\theta = \phi}$

for anti = $\boxed{\theta = 360 - \phi}$

② ellipse in 2nd & 4th quad'



$$\phi = 180 - \sin^{-1}\left(\frac{x_1}{x_2}\right) = 180 - \sin^{-1}\left(\frac{y_1}{y_2}\right)$$

for clockwise $\boxed{\theta = \phi}$

for Anti : $\boxed{\theta = 360 - \phi}$

finding Unknown freq. from known frequency using L-pattern:

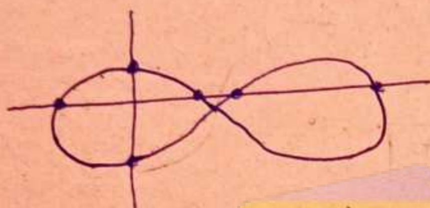
$V_x = V_m \sin \omega_x t$

$V_y = V_m \sin \omega_y t$

$\omega_x \neq \omega_y$

$$\boxed{\frac{f_y}{f_x} = \frac{\text{Maximum number of horizontal Tangencies / intersection}}{\text{Maximum number of vertical Tangencies / intersections}}}$$

eg)



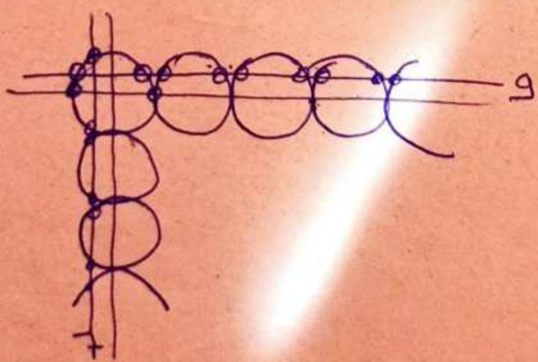
be a L-pattern

Hori = 4
Verti = 2

$$\boxed{\frac{f_y}{f_x} = \frac{4}{2} = 2}$$

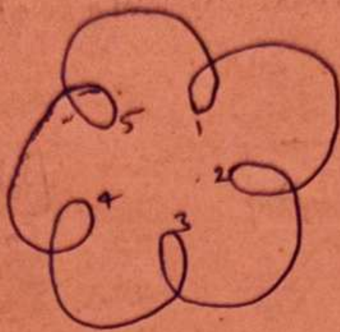
$$\boxed{f_y = 2f_x}$$

eg)



$$\boxed{\frac{f_y}{f_x} = \frac{9}{7}}$$

eg)



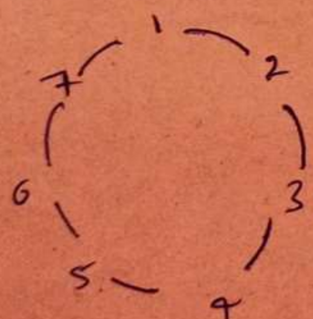
$$\boxed{\frac{f_y}{f_x} = \frac{1}{5}}$$

eg)

$$\boxed{\frac{f_y}{f_x} = \frac{1}{5}}$$

these are special cases

eg)



$$\boxed{\frac{f_y}{f_x} = \frac{1}{7}}$$

Bandwidth :- Max^m undistorted frequency obtained in CRO is known as BW.

$$\boxed{(B.W).\,t_r = 0.35}$$

[where t_r = rise time]
[B.W = bandwidth]

Measurement using CRO :-

① calibrate CRO using Pulse or square signal

② we can measure ⓐ frequency ⓑ Phase difference

ⓒ voltage ⓓ current

③ Power cannot be calculated by CRO.

④ if $V_{p-p} > (V_{p-p})_{max}$ ⇒ signal is clipped

⑤ $V_{RMS} = \frac{V_m}{\sqrt{2}}$

⑥ $\boxed{V_{p-p} = 2V_m}$ so ** $\boxed{V_{RMS} = \frac{V_{p-p}}{2\sqrt{2}}}$