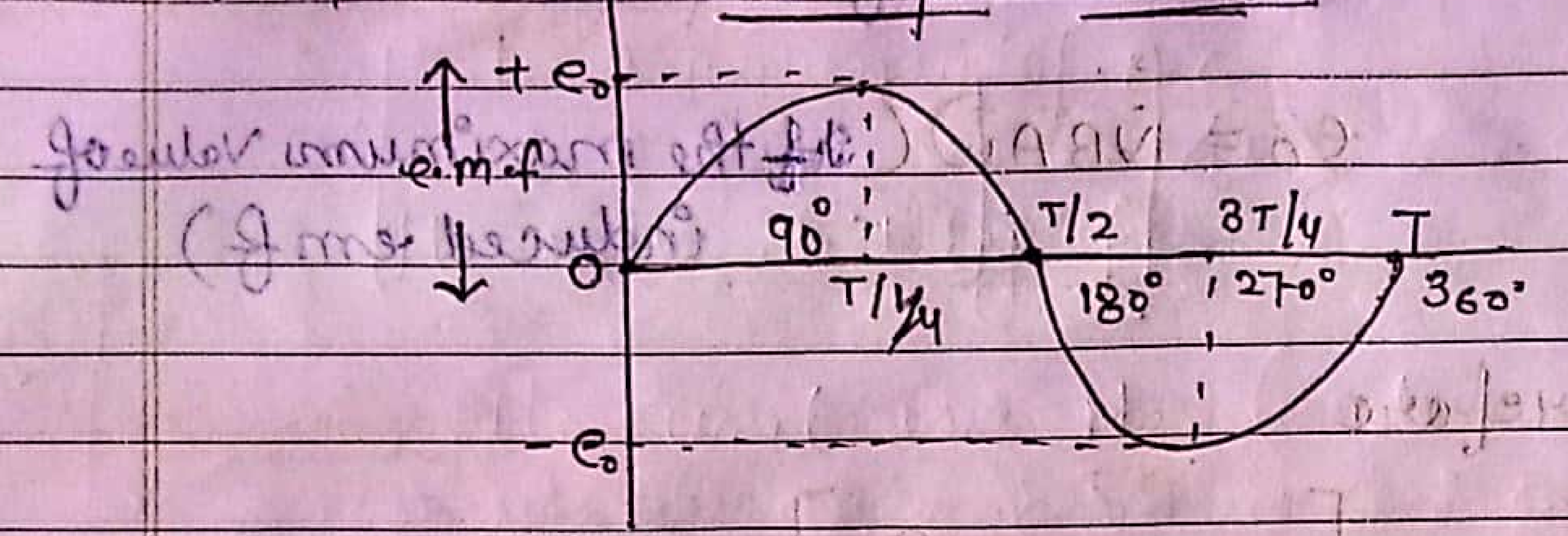
ch-07 :- Alternating Current :

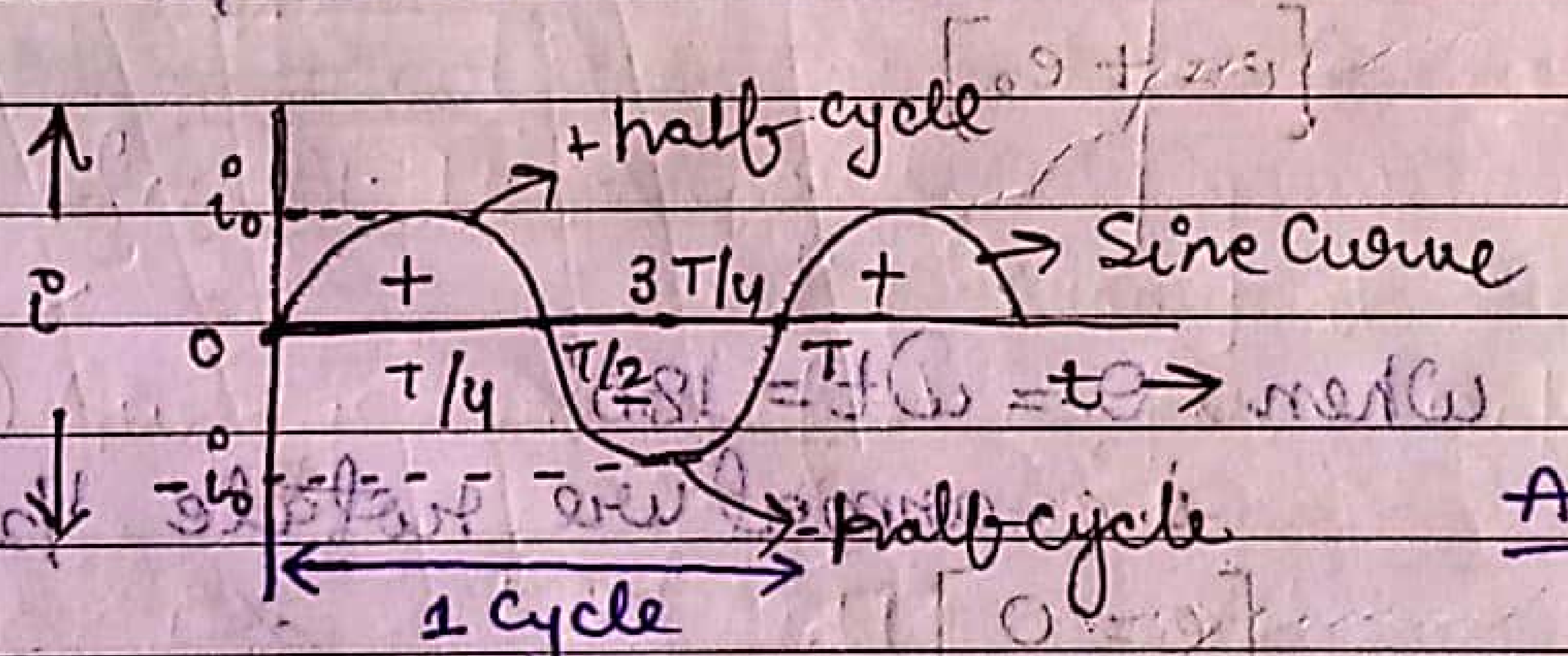


A Current of Constant amplitude which Continuously Varies in magnitude with time and Change its direction periodically is Called Alternating current.

Its eqn is — $i = i_0 \sin \omega t$

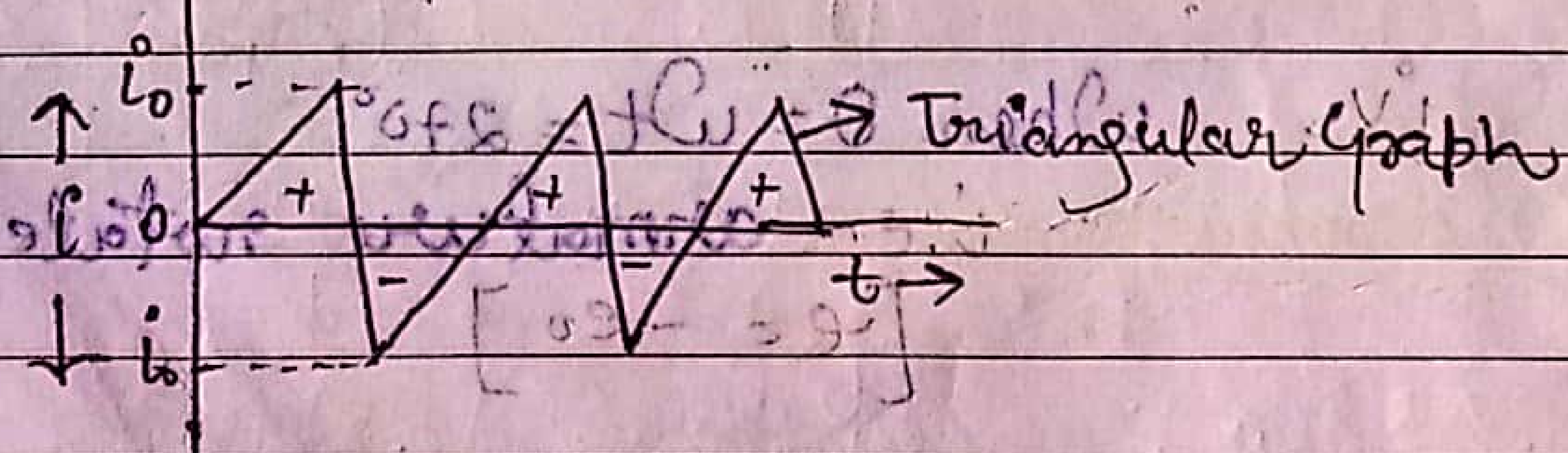
where i_0 = Amplitude of AC

①



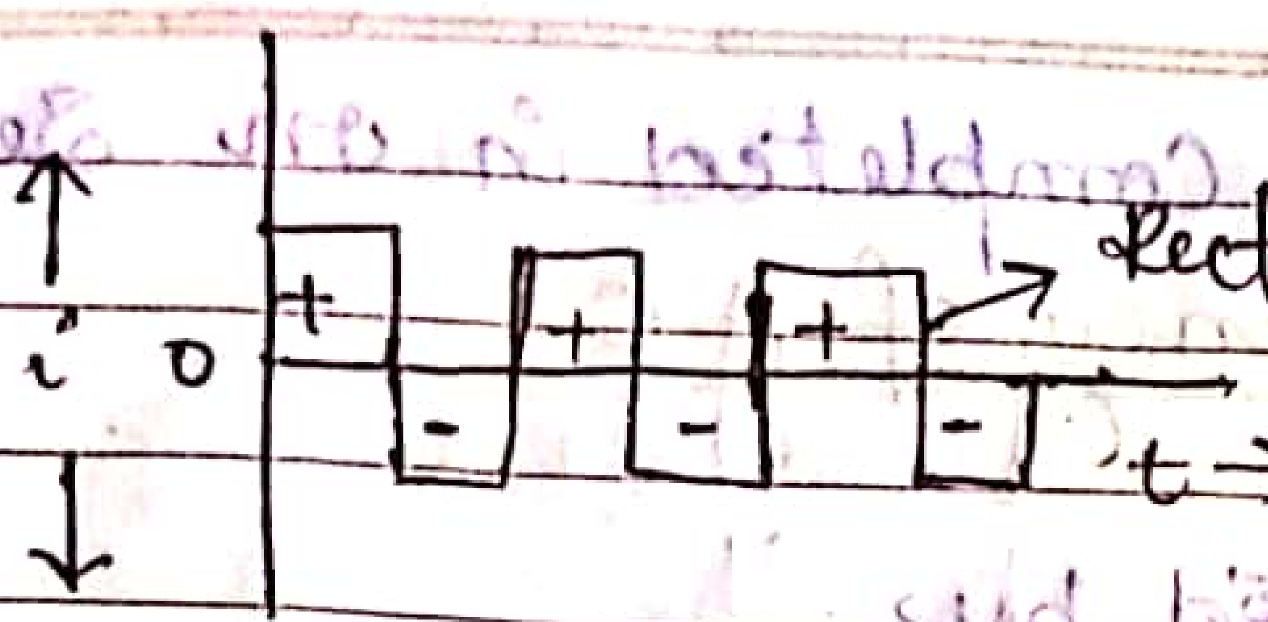
AC

②



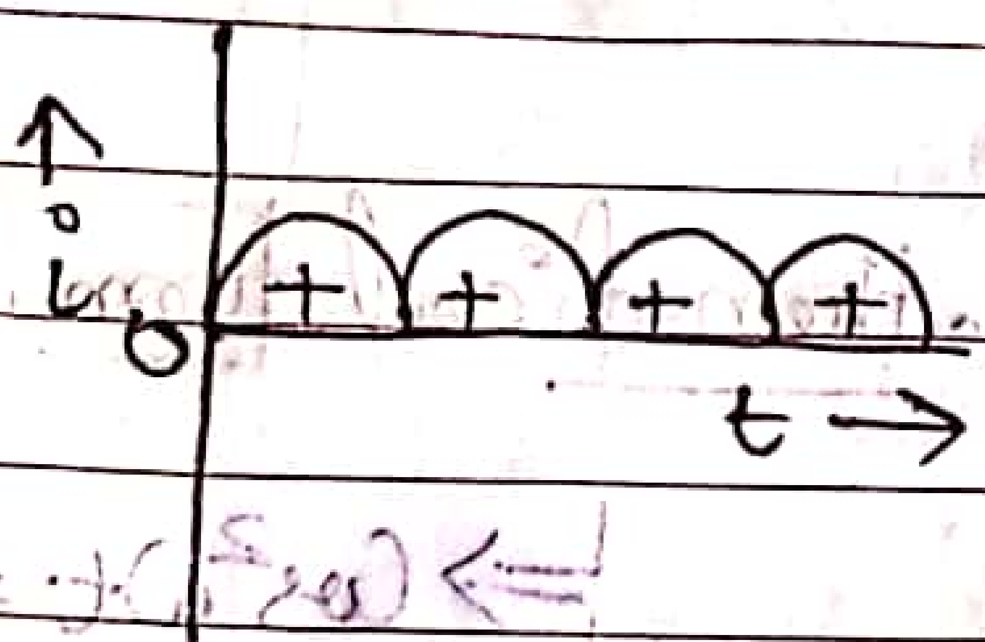
It is also AC

③

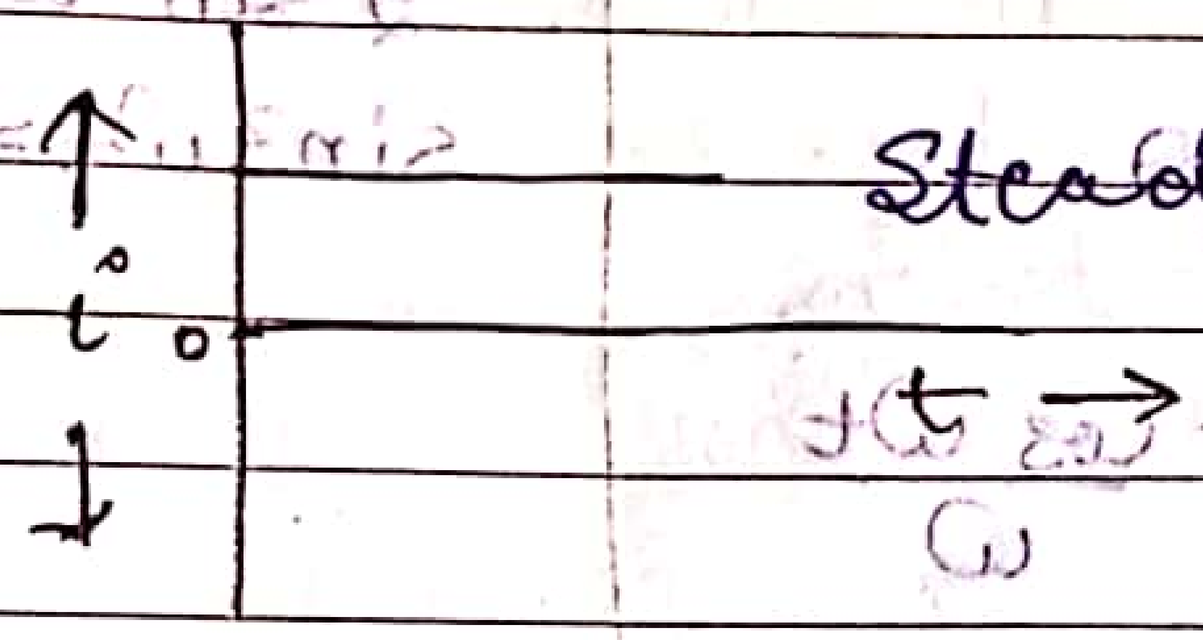


It is also AC

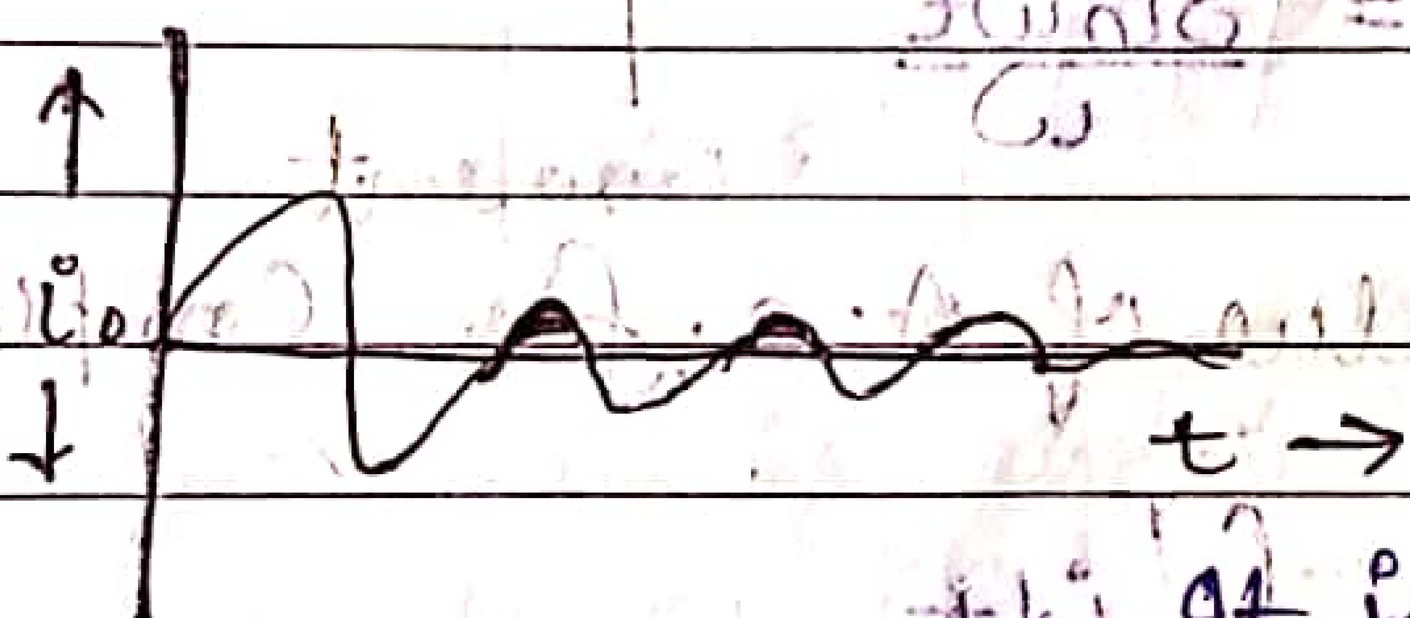
④



⑤



⑥



It is neither AC nor DC

★

① → The time taken to complete one cycle is called time period of AC

It is denoted by T

$$\boxed{T = \frac{2\pi}{\omega}}$$

Note- The average Value of any x is denoted by $\langle x \rangle$ or $\bar{x}$ or x_{av}

→ The no. of cycle completed in on second is called Frequency of A.C.

It is denoted by f

its unit is Hz (cycle/sec)

☆ Some Important Mathematical Formula

$\Rightarrow \int \cos\theta \, d\theta = \sin\theta$

$\Rightarrow \int \sin\theta \, d\theta = -\cos\theta$

$\Rightarrow \int \sin\omega t \, dt = -\frac{\cos\omega t}{\omega}$

$\Rightarrow \int \cos\omega t \, dt = \frac{\sin\omega t}{\omega}$

$\Rightarrow \cos^2\omega t = 1 - 2\sin^2\omega t$

$2\sin^2\omega t = 1 - \cos 2\omega t$

$\sin^2\omega t = \left[\frac{1}{2} - \frac{\cos 2\omega t}{2}\right]$

① Average Value of A.C. current for Complete one cycle.

$$\langle i \rangle = \frac{1}{T}\int_0^T i\,dt$$

$$= \frac{1}{T}\int_0^T i_0 \sin\omega t \, dt$$

$$= \frac{i_0}{T}\int_0^T \sin\omega t \, dt$$

$$= \frac{i_0}{T}\left[\frac{-\cos\omega t}{\omega}\right]_0^T \quad \because \omega = \frac{2\pi}{T}$$

$$= \frac{i_0}{T\omega}\left[-\cos\omega T + \cos 0\right]$$

$\sin 2\pi, 6\pi, 8\pi, 10\pi$ etc $= 0$

even $\sin\pi$

$$= \frac{i_0}{T\omega}\left[-\cos\frac{2\pi}{T}\times T + \cos 0\right]$$

$$\langle i \rangle = \frac{i_0}{T\omega}\left[-\cos 2\pi + \cos 0\right]$$

$$= \frac{i_0}{T\omega}\left[-1+1\right]$$

$$\bigstar \left[= \langle i \rangle = 0\right]$$

② Average value of A.C for half cycle

current

$$\langle i \rangle = \frac{1}{(T/2)}\int_0^{T/2} i\,dt$$

$$= \frac{2}{T}\int_0^{T/2} i_0 \sin\omega t\,dt$$

$$= \frac{2i_0}{T}\left[-\frac{\cos\omega t}{\omega}\right]_0^{T/2}$$

$$= \frac{2i_0}{T\omega}\left[-\cos\omega\frac{T}{2} + \cos 0\right]$$

$$= \frac{2i_0}{T\omega}\left[-\cos\frac{2\pi}{T}\times\frac{T}{2} + \cos 0\right]$$

$$\langle i \rangle = \frac{2i_0}{\frac{2\pi}{\omega}\times\omega}\left[-\cos\pi + 1\right]$$

$$\langle i \rangle = \frac{i_0}{\pi}\left[1+1\right]$$

$$\left[\langle i \rangle = +\frac{2i_0}{\pi}\right] \rightarrow \left[\langle i \rangle = +0.637\, i_0\right]$$

The average value of A.C current for -ve half cycle

$$\left[\langle i \rangle = -\frac{2i_0}{\pi}\right] \rightarrow \left[\langle i \rangle = -0.637\, i_0\right]$$

Similarly the average value of A.C. voltage for one half cycle.

$$\langle V \rangle = +\frac{2V_0}{\pi}$$

For another half cycle

$$\langle V \rangle = -\frac{2V_0}{\pi}$$

Root mean Square Value of AC

$$[i_{rms}]$$

The square root of average value of square of AC for one cycle is called rms value of alternating current.

$$i_{rms} = \sqrt{\overline{i^2}} \text{ for complete one cycle}$$

$$\overline{i^2} = \frac{1}{T}\int_0^T i^2\,dt$$

$$\overline{i^2} = \frac{1}{T}\int_0^T i_0^2 \sin^2\omega t\,dt$$

$V_{rms} = 220V.$

$220 = \frac{V_0}{\sqrt{2}}$

$V_0 = 220\sqrt{2} = 311$ volt

$$\overline{i^2} = \frac{i_0^2}{T}\int_0^T\left[\frac{1}{2} - \frac{\cos 2\omega t}{2}\right]dt$$

$$\overline{i^2} = \frac{i_0^2}{T}\left[\int_0^T \tfrac{1}{2}dt - \frac{1}{2}\int_0^T \cos 2\omega t\,dt\right]$$

$$\overline{i^2} = \frac{i_0^2}{T}\left[\frac{T}{2} - \frac{1}{2}\left[\frac{\sin 2\omega t}{2\omega}\right]_0^T\right]$$

$$\overline{i^2} = \frac{i_0^2}{T}\left\{\frac{T}{2} - \frac{1}{2}\left[\frac{\sin 2\omega t}{2\omega} - \sin 0\right]\right\}$$

$$\overline{i^2} = \frac{i_0^2}{T}\left\{\frac{T}{2} - \frac{1}{4\omega}\left[\sin 2\times\frac{2\pi}{T}\times T - 0\right]\right\}$$

$$\overline{i^2} = \frac{i_0^2}{\cancel{T}}\times\frac{\cancel{T}}{2} \qquad \because \sin 4\pi = 0$$

$$\overline{i^2} = \frac{i_0^2}{2}$$

Therefore

$$i_{rms} = \sqrt{\frac{i_0^2}{2}}$$

$$\left[i_{rms} = \frac{i_0}{\sqrt{2}}\right]$$

similarly

$$\left[V_{rms} = \frac{V_0}{\sqrt{2}}\right]$$

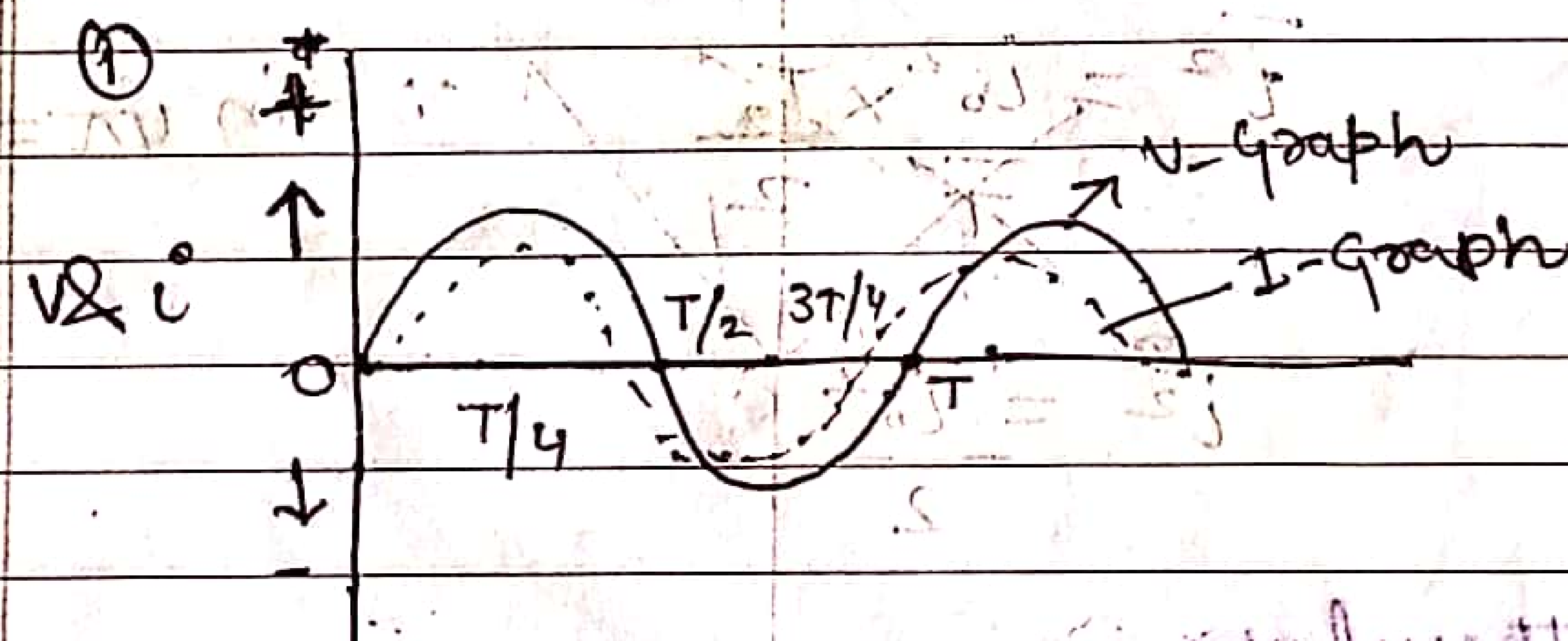
Phase difference b/w A.C (Current) and AC Voltage.

① → When V and i both are in same phase.

→ To show the phase relationship b/w Voltage and current in an A.C circuit we use the phaser diagram.

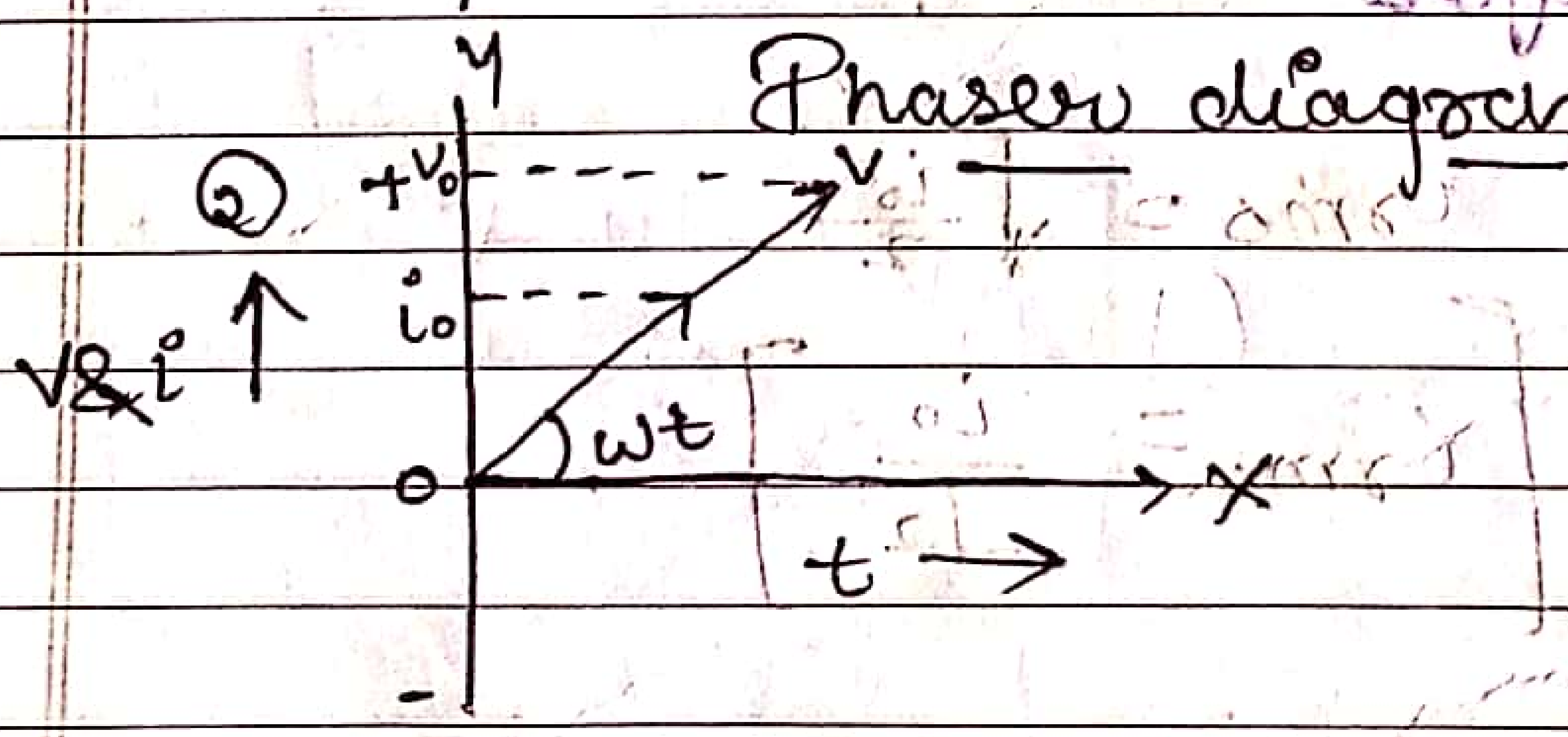
"The phaser diagram is the rotating vector representating A.C and voltage."

①



Phaser diagram

②



③

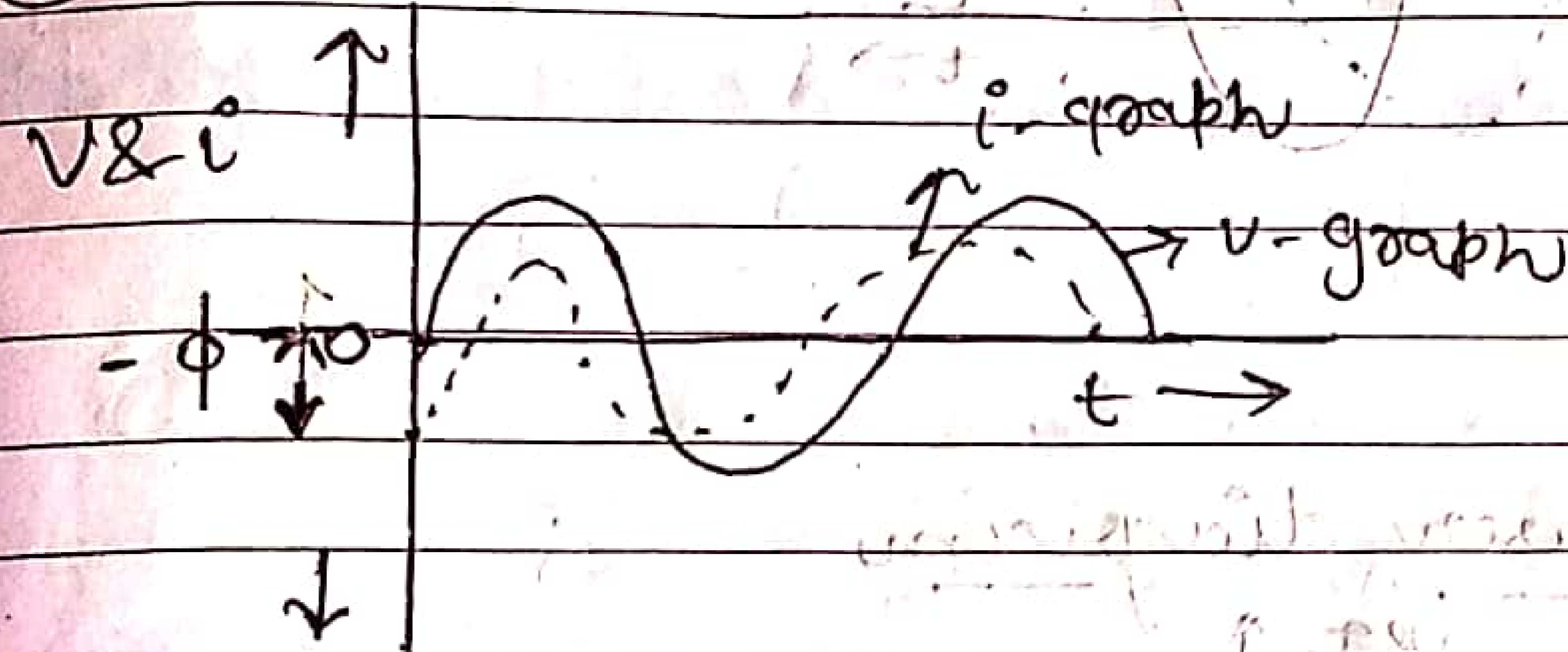
$$\left[\begin{array}{l} V = V_0 \sin \omega t \\ i = i_0 \sin \omega t \end{array}\right]$$

(iii) When AC voltage V is leading by ϕ phase with i

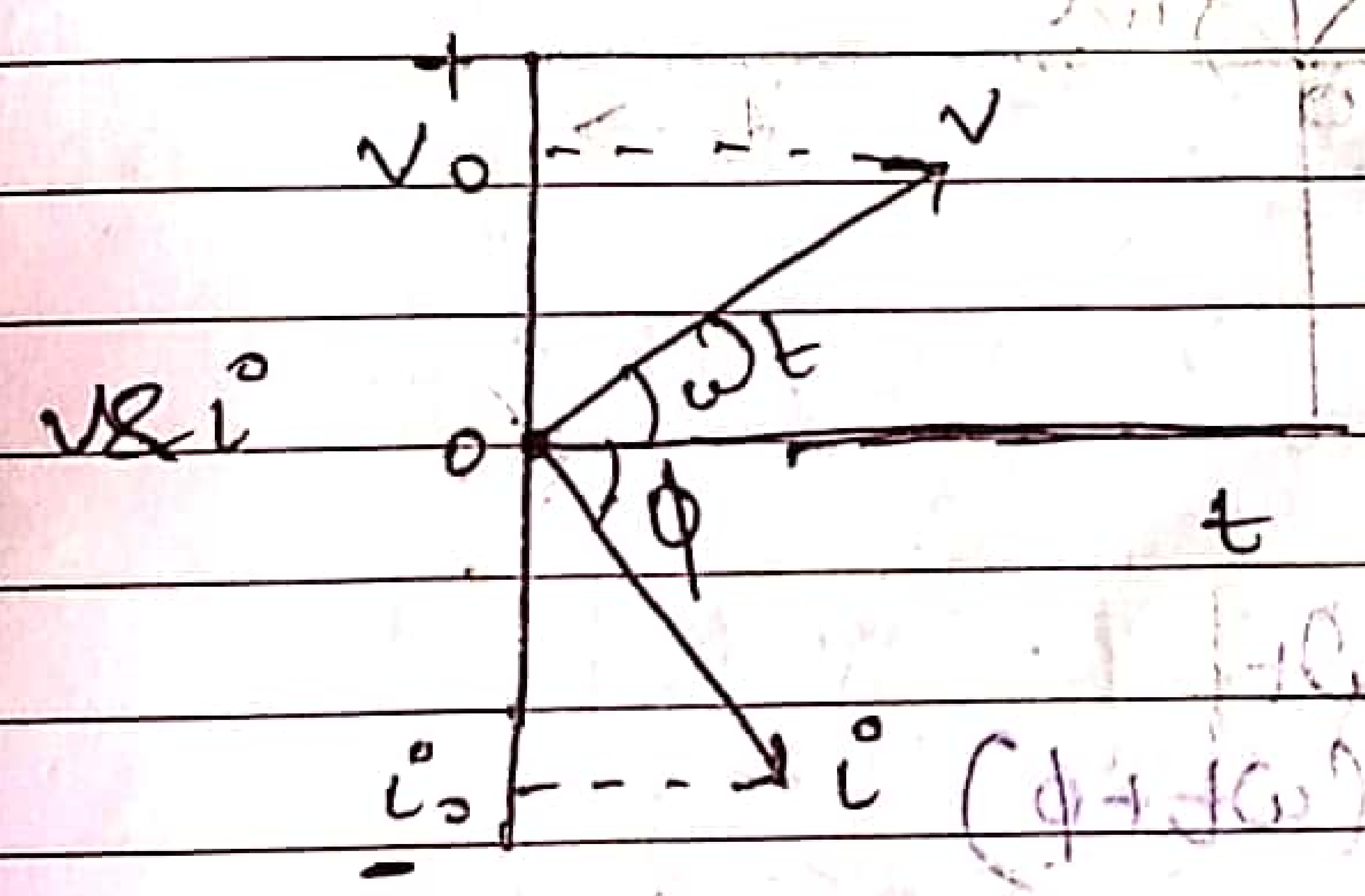
or

i is lagging by ϕ phase with V

(1)



(2) Phaser diagram



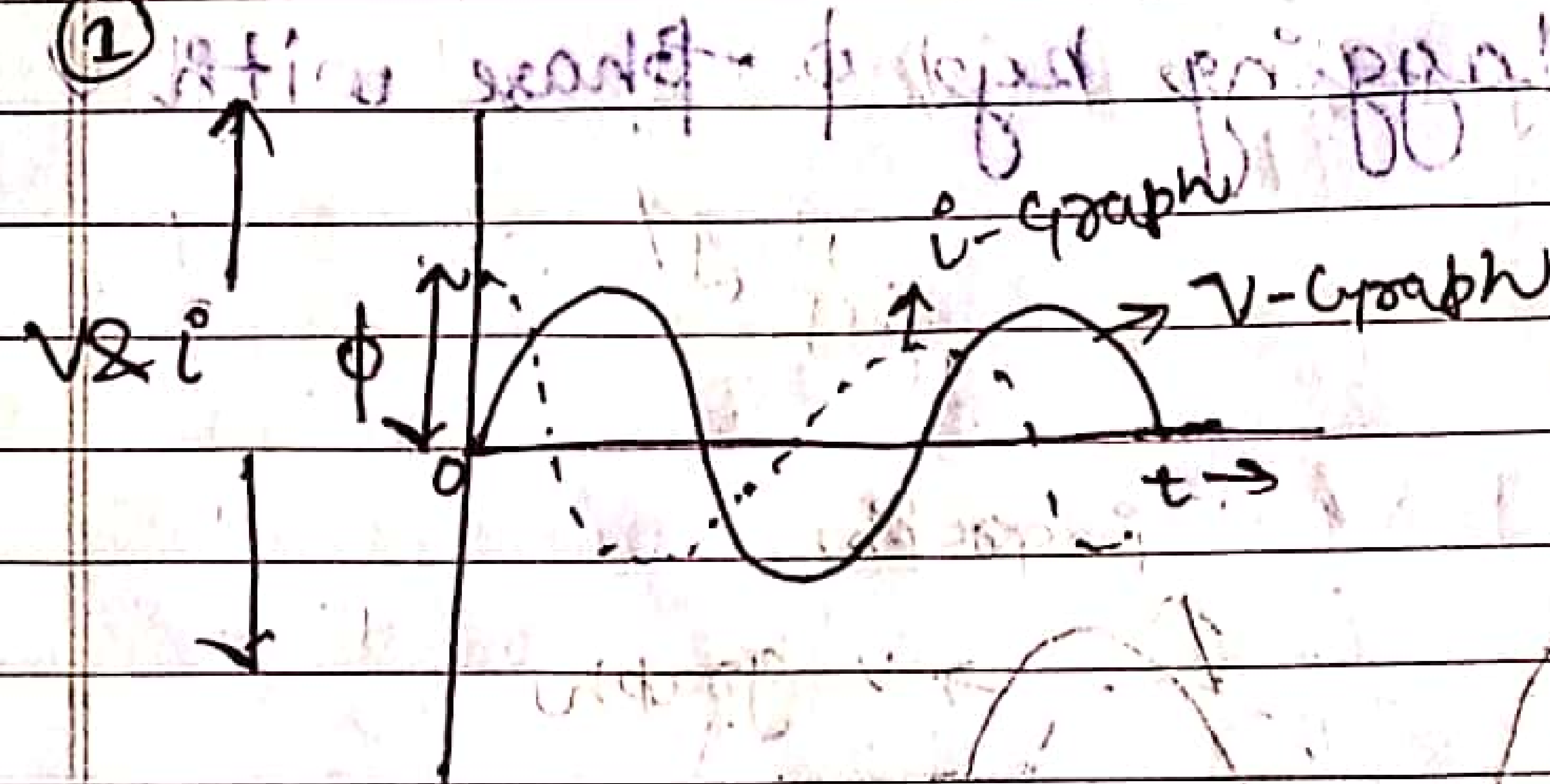
(3)
$$\left[\begin{array}{l} V = V_0 \sin \omega t \\ i = i_0 \sin(\omega t - \phi) \end{array}\right]$$

or

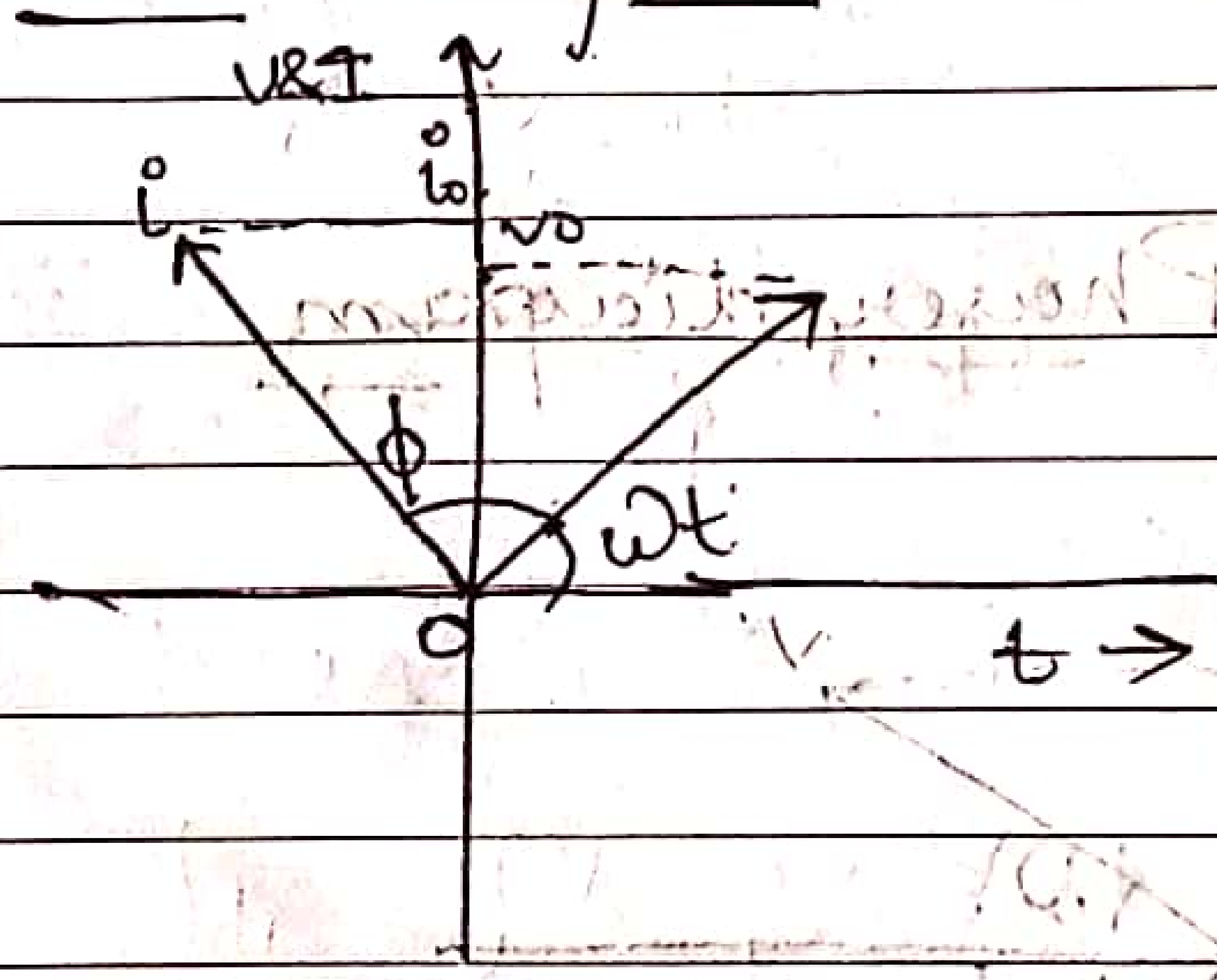
$$\left[\begin{array}{l} V = V_0 \sin(\omega t + \phi) \\ i = i_0 \sin \omega t \end{array}\right]$$

(iii) When Voltage lages Current by phase ϕ or the Current leading Voltage by phase ϕ

(1)



(2) Phaser diagram



(3)

$v = v_0 \sin \omega t$

$i = i_0 \sin(\omega t + \phi)$

OR

$i = i_0 \sin \omega t$

$v = v_0 \sin(\omega t - \phi)$

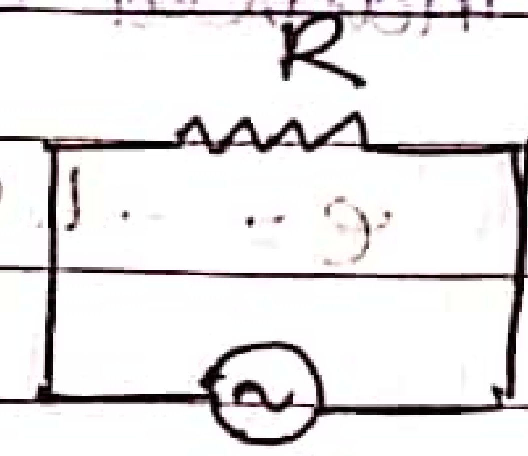
so

NOTES →

Different types of A.C circuit

① When there is only a resistor · R-ckt

$V = V_0 \sin \omega t$ — ①



The Voltage across R

$V = V_0 \sin \omega t$ will be

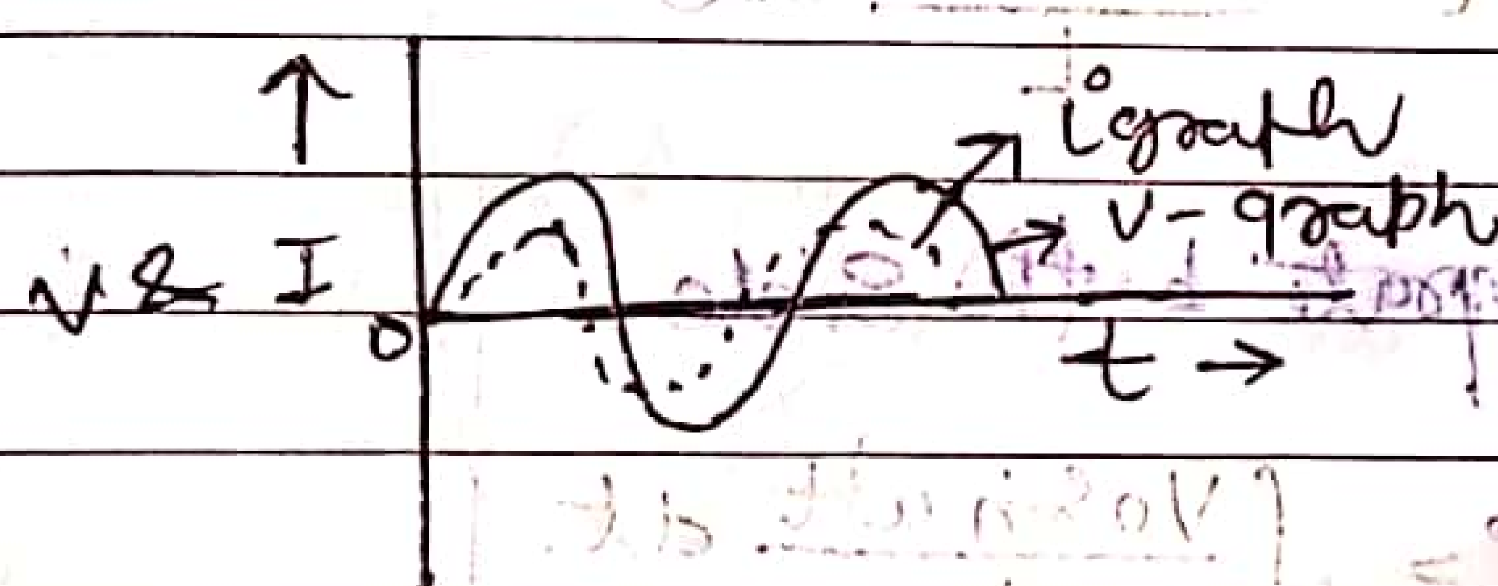
$V = iR$

$i = \frac{V}{R} = \frac{V_0 \sin \omega t}{R}$

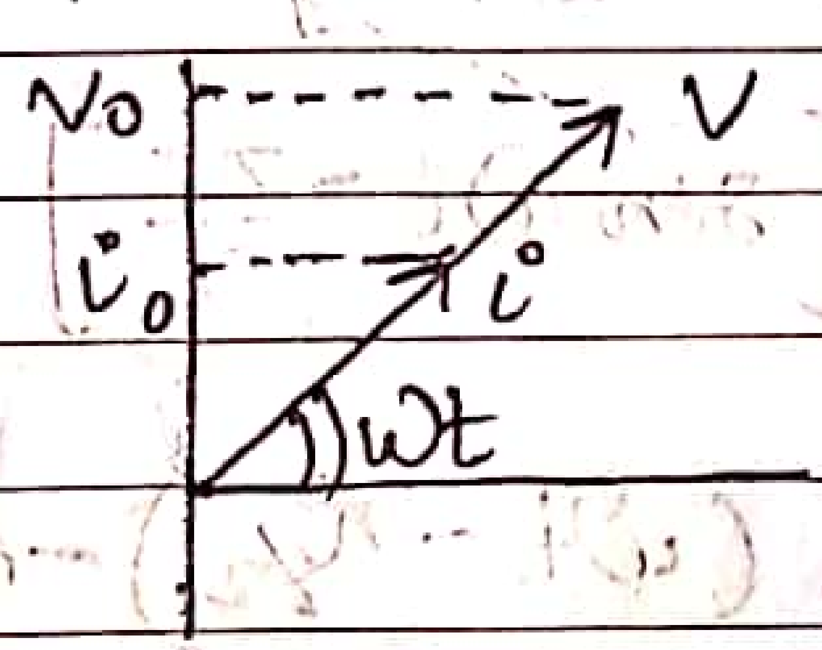
$\because \frac{V_0}{R} = i_0$

$i = i_0 \sin \omega t$ — ②

In R-ckt the V & i will be in same phase.

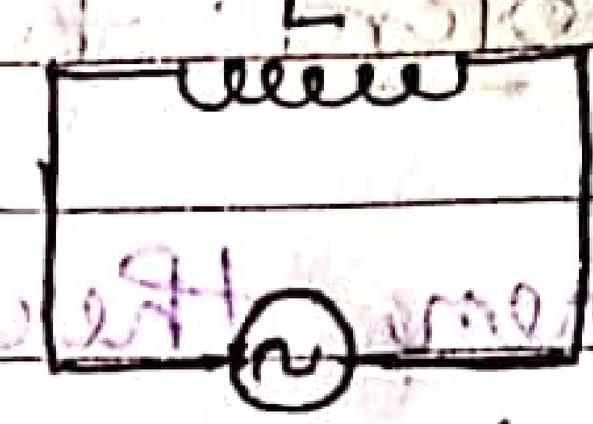


Phaser diagram



② L.H. ckt (Inductance)

$V = V_0 \sin \omega t$ — ①



$V = V_0 \sin \omega t$

The induced e.m.f across L

$$e = -L \frac{di}{dt}$$

To maintain current in ckt the applied voltage will be.

$$V = -e$$

$$V = L \frac{di}{dt}$$

$$di = \frac{V}{L} dt$$

$$di = \frac{V_0 \sin \omega t}{L} dt$$

Integrate both side

$$\int di = \int \frac{V_0 \sin \omega t}{L} dt$$

$$i = \frac{V_0}{L}\left[\frac{-\cos \omega t}{\omega}\right]$$

$$i = \frac{V_0}{\omega L}\left[\sin\left(\omega t - \frac{\pi}{2}\right)\right]$$

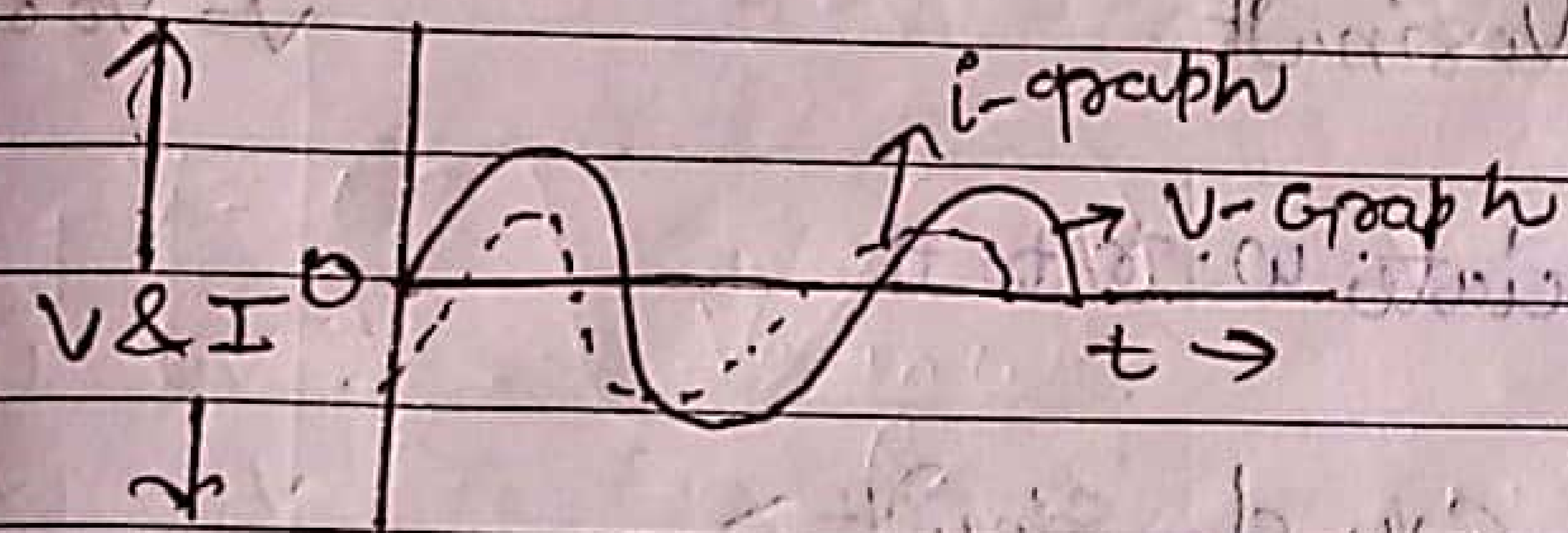
$$i = i_0 \sin\left(\omega t - \pi/2\right) \text{ — ②}$$

where $i_0 = \frac{V_0}{\omega L}$

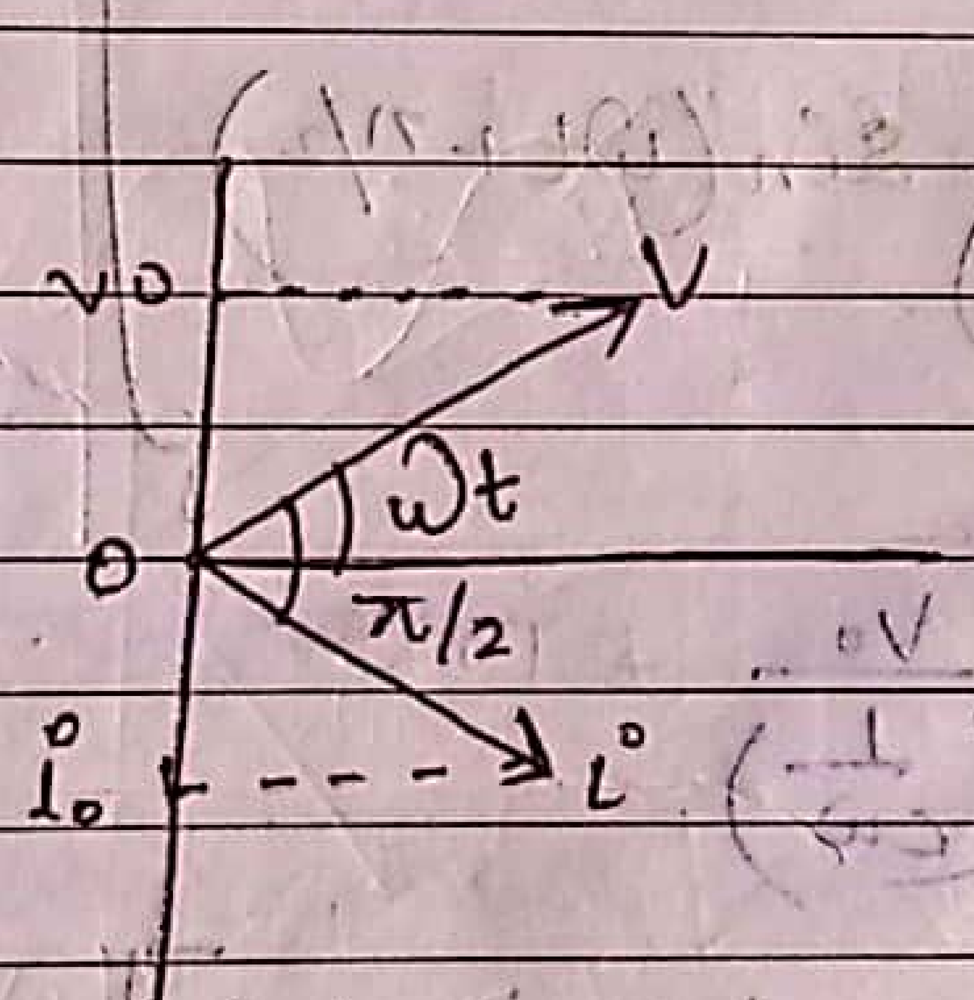
NOTES → R → Resistance
X_L → Inductive Reactance
X_C → Capacitive Reactance
Z → Impedance Reactance
] unit Ω

⇒ In L-ckt the voltage leading with current by phase $\pi/2$

Or the current lagging with voltage by phase $\pi/2$



Phasor Graph



$\frac{V_0}{i_0} = \omega L$

$\frac{V_0}{i_0}$ = Resistance of ckt

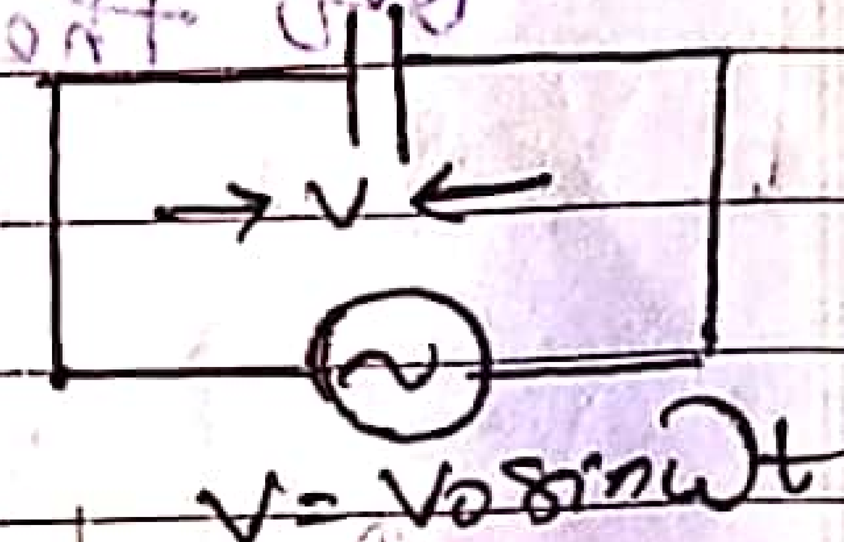
$\frac{V_0}{i_0} = X_L$ = Inductive Reactance

$[X_L = \omega L]$

The SI unit of Inductive Reactance – (Ω) ohm

③ C – circuit

When there is only capacitor in AC Circuit.



$q = CV$

$q = CV_0 \sin\omega t$

differenciate w.r/to t

$$\frac{dq}{dt} = CV_0 \frac{d}{dt} \sin\omega t$$

$$i = CV_0 \times (\cos\omega t) \times \omega$$

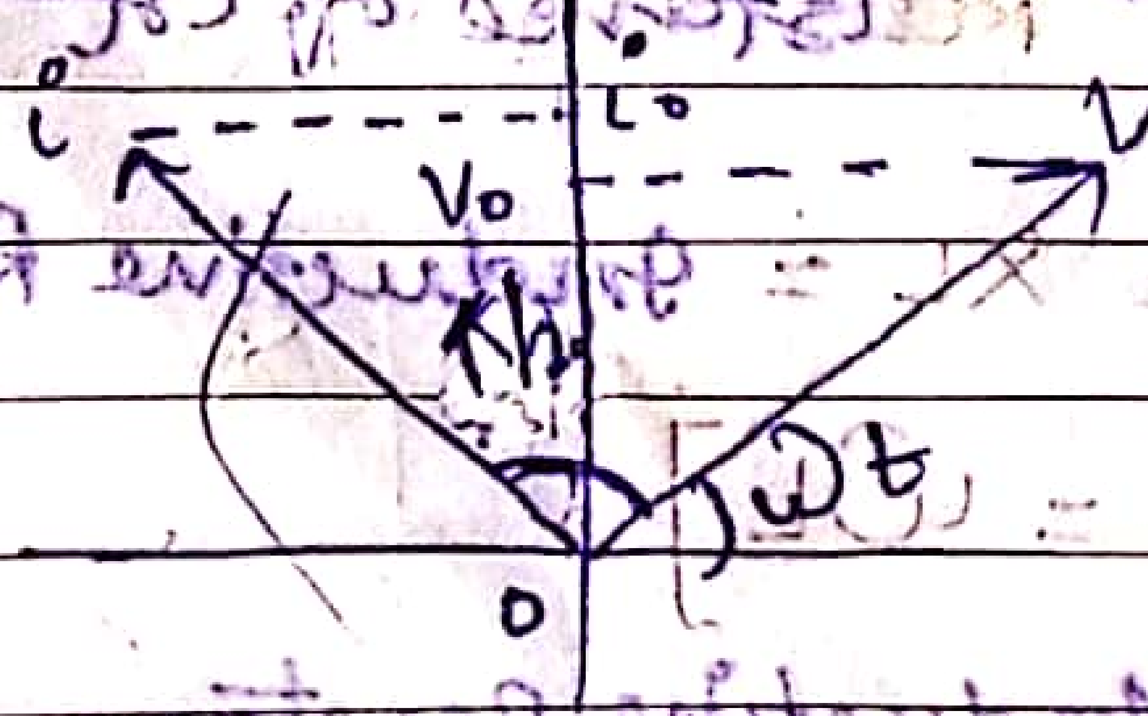
$$i = C\omega V_0 \cos\omega t$$

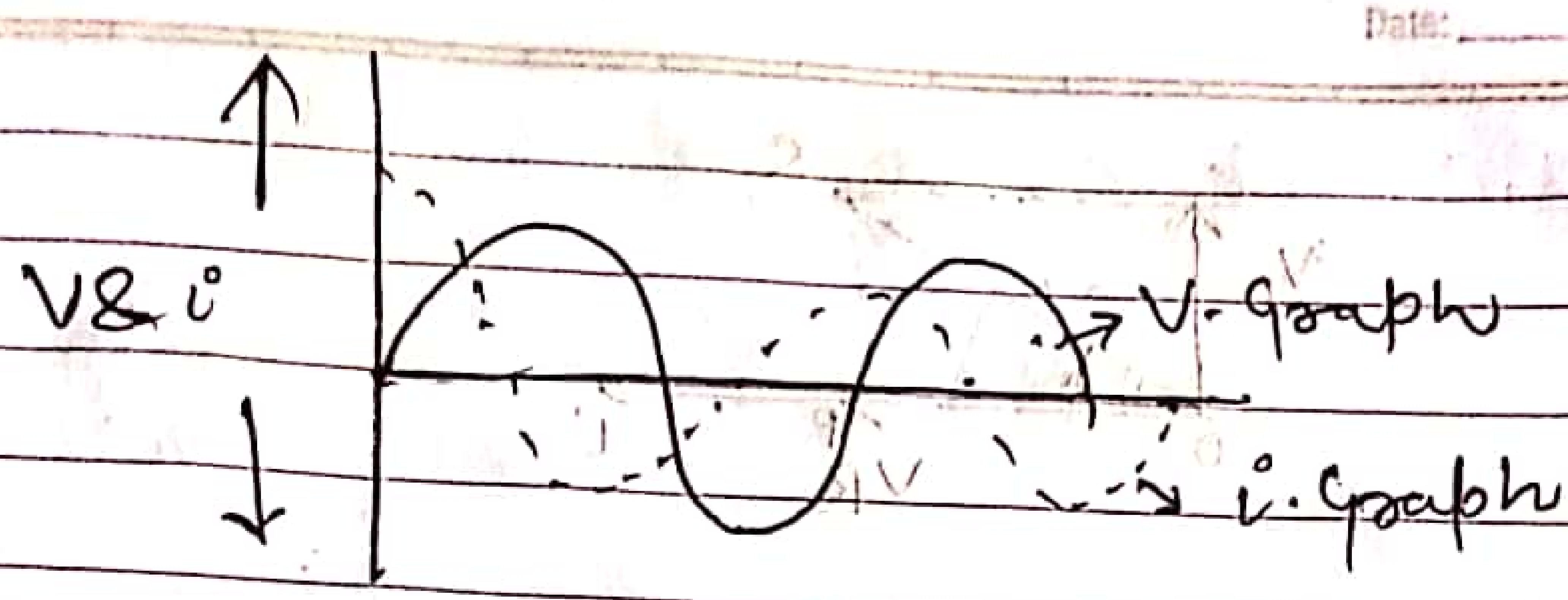
$$\boxed{i = \frac{V_0}{\left(\frac{1}{C\omega}\right)} \sin\left(\omega t + \pi/2\right)}$$

$$i = \frac{V_0}{\left(\frac{1}{C\omega}\right)} = i_0$$

$$\therefore \boxed{i = i_0 \sin\left(\omega t + \pi/2\right)}$$

Phasor diagram





$$\because i_0 = \frac{V_0}{\left(\frac{1}{C\omega}\right)}$$

$$\left(\frac{V_0}{i_0}\right) = \frac{1}{C\omega}$$

$$\left[X_C = \frac{1}{\omega C}\right] \qquad \because \omega = 2\pi f \qquad \left[X_C = \frac{1}{2\pi f C}\right]$$

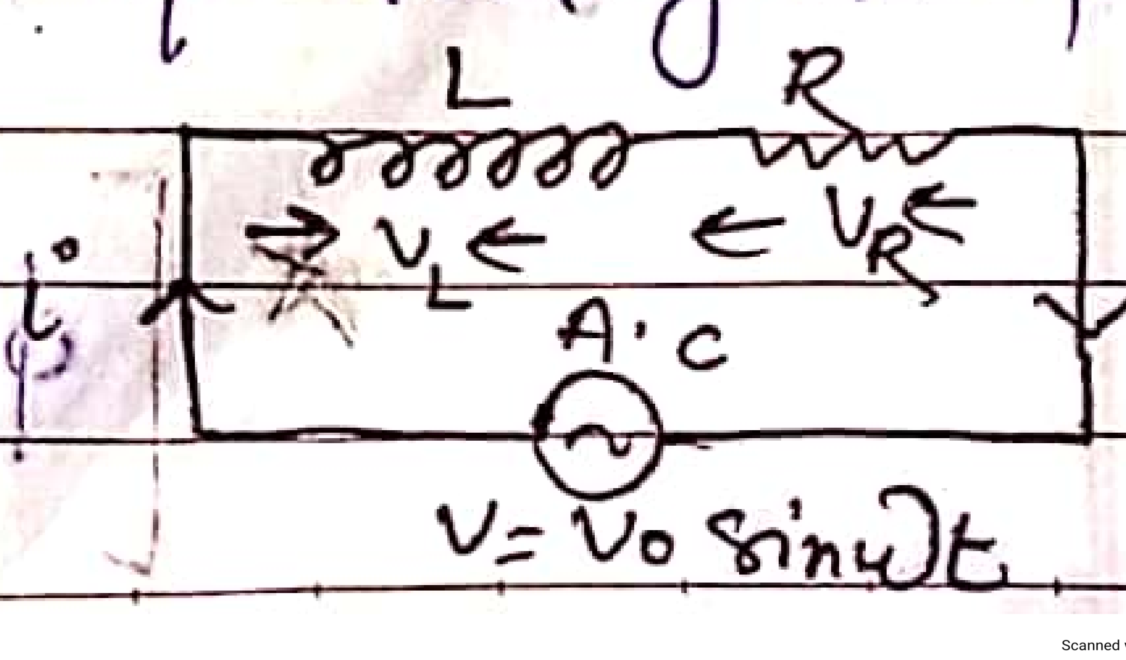
↳ Capacitive Reactance

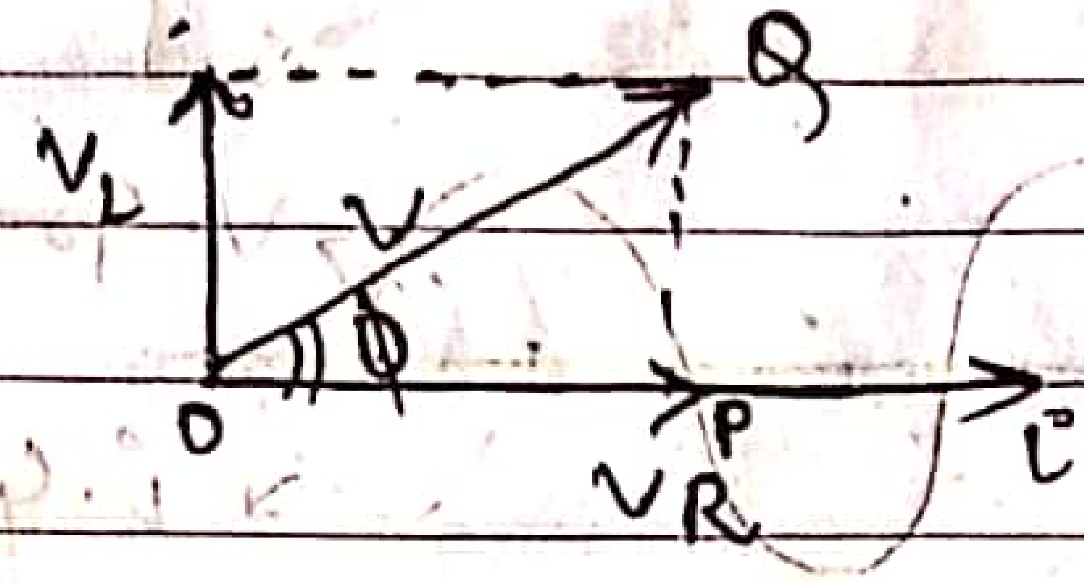
★ " Therefore in C-ckt current lead voltage by phase $\pi/2$ "

or, voltage lags current by phase $\pi/2$

L-R Circuit

~~Let the phase difference b/w voltage and current is ϕ.~~





Resultant potential

$$V^2 = V_R^2 + V_L^2$$

$$V = \sqrt{V_R^2 + V_L^2}$$

$\because V_R = iR$

$V_L = iX_L$

$$V = \sqrt{i^2R^2 + i^2X_L^2}$$

$$\frac{V}{i} = \sqrt{R^2 + X_L^2}$$

$\frac{V}{i}$ is called impedence of the ckt

it is denoted by Z

$$\therefore Z = \sqrt{R^2 + X_L^2} \quad \because X_L = \omega L$$

$$Z = \sqrt{R^2 + (\omega L)^2}$$

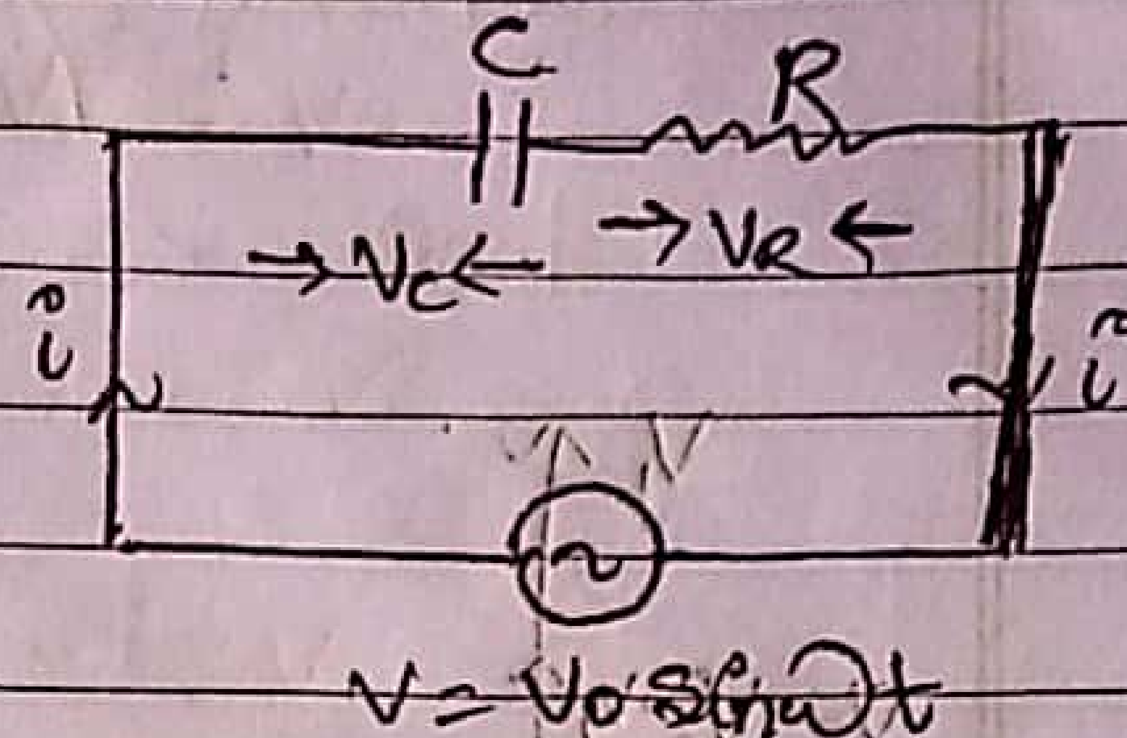
The unit of Z is ohm (Ω)

Let the phase diff. b/w i & v is ϕ.

In $\Delta POQ = \frac{PQ}{OP} = \frac{V_L}{V_R} = \frac{\cancel{i}X_L}{\cancel{i}R} = \frac{\omega L}{R}$

$$\bigstar \left[\phi = \tan^{-1}\left(\frac{\omega L}{R}\right)\right]$$

C-R Circuit



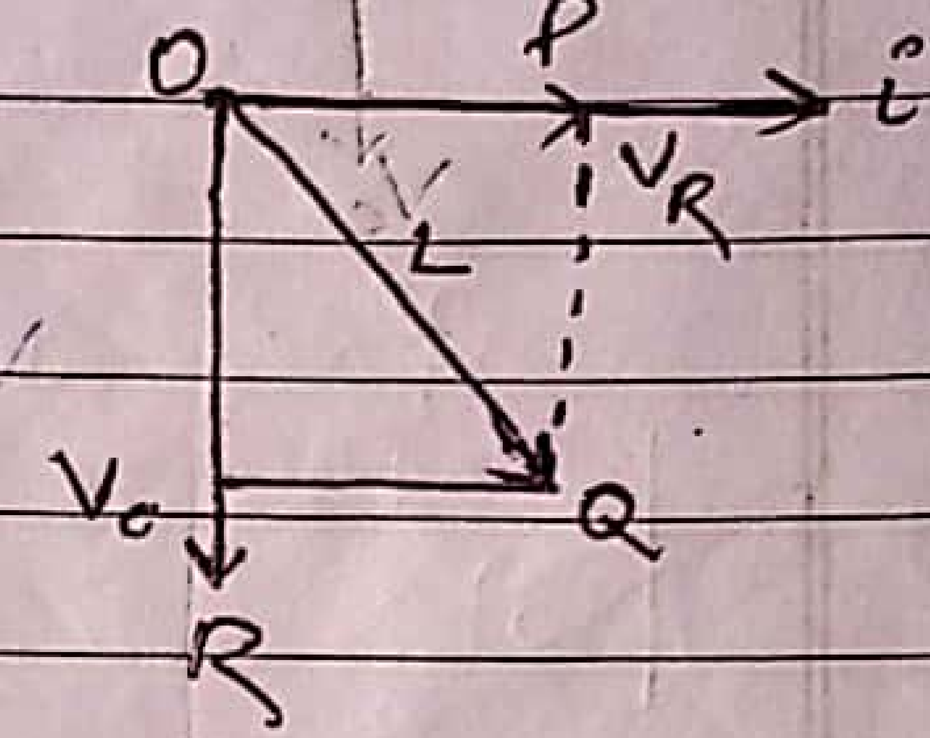
Resultant Voltage

$$V = \sqrt{V_R^2 + V_C^2}$$

$\because V_R = iR$

$V_C = i X_C$

$= i \times \frac{1}{\omega C}$



$$V = \sqrt{i^2 R^2 + i^2 \left(\frac{1}{\omega C}\right)^2}$$

$$V = i\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$$

$$\frac{V}{i} = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$$

$\frac{V}{i}$ is impedance of ckt

$$\left[Z = \sqrt{R^2 + \frac{1}{(\omega C)^2}} \right]$$

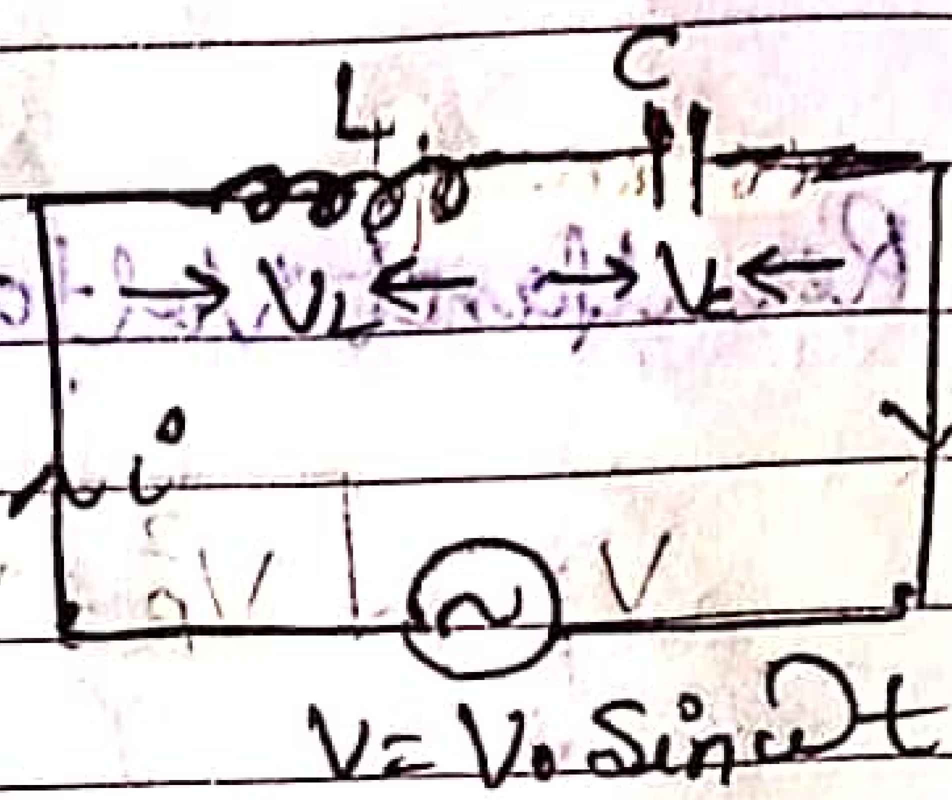
Let the phase diff. b/w. i & v is ϕ

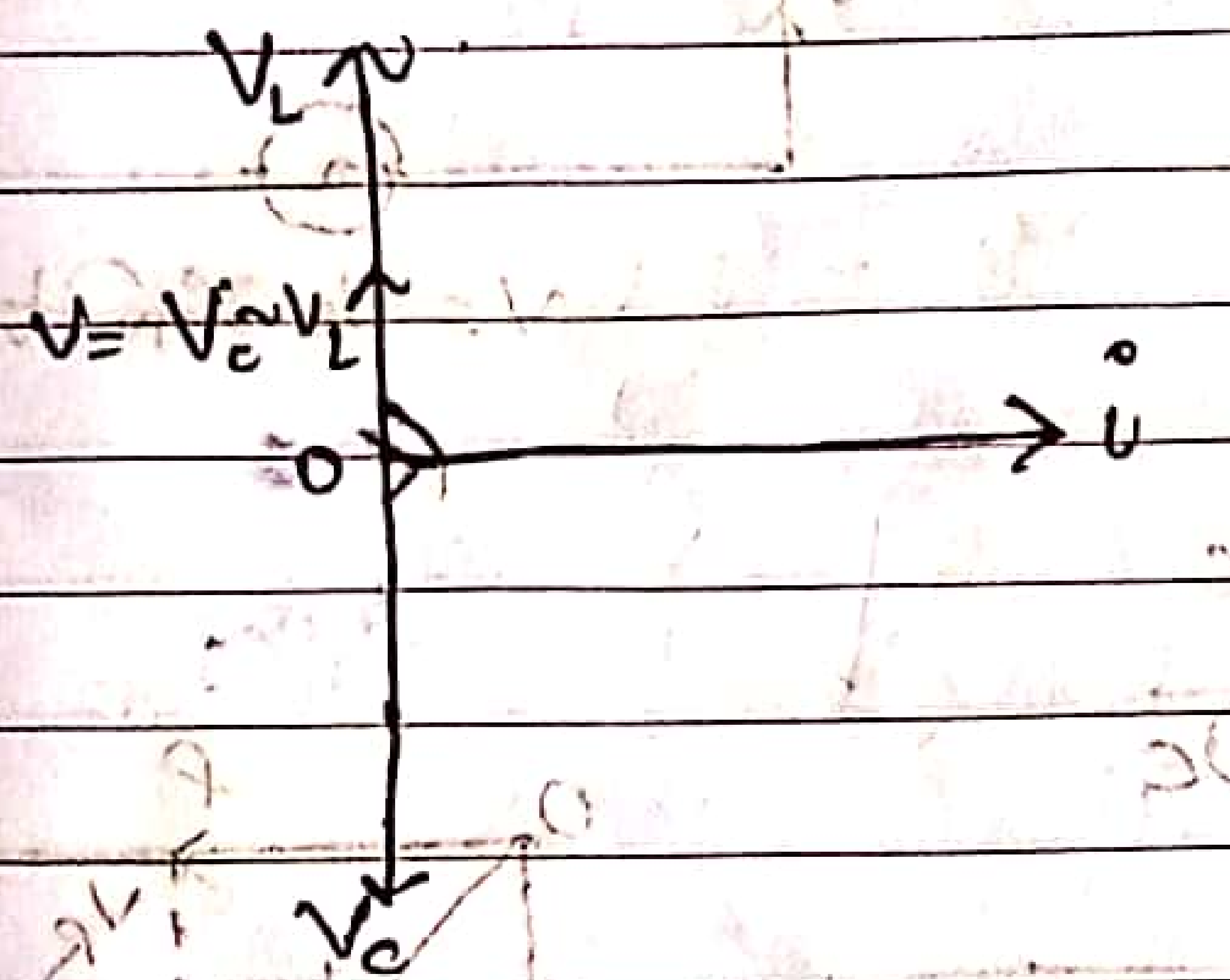
$$\tan\phi = \frac{PQ}{OP} = \frac{V_C}{V_R} = \frac{i X_C}{i R} = \frac{1}{\omega C R}$$

$$\tan\phi = \frac{1}{\omega C R}$$

$$\star \left[\phi = \tan^{-1}\left(\frac{1}{\omega C R}\right) \right]$$

L-C Crt





$$V = V_L \sim V_C$$

$$\therefore V_L = i X_L$$
$$V_C = i X_C$$

$$V = i X_L \sim i X_C$$

$$\frac{V}{i} = X_L \sim X_C$$

$\frac{V}{i}$ is the impedence of crt

$$[Z = X_L \sim X_C]$$

The phase difference b/w Res. voltage and current will be $\pi/2$

Electrical Resonance

When, $X_L = X_C$
then $[Z = 0]$

In this condition the amplitude of current will be maximum.

At electrical Resonance

$$X_L = X_C$$

$$\omega L = \frac{1}{\omega C}$$

$$2\pi f L = \frac{1}{2\pi f C}$$

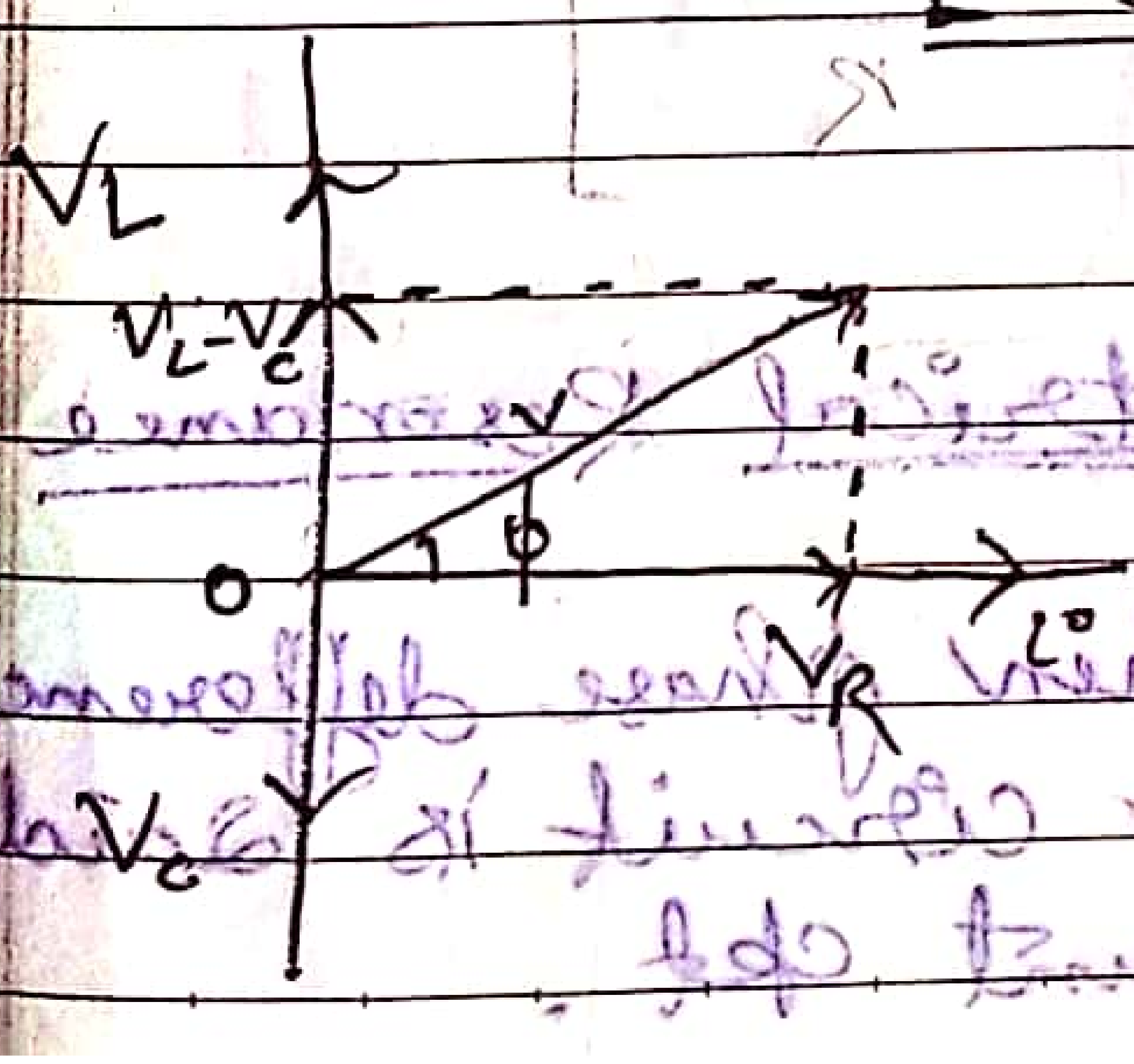
$$f^2 = \frac{1}{4\pi^2 LC}$$

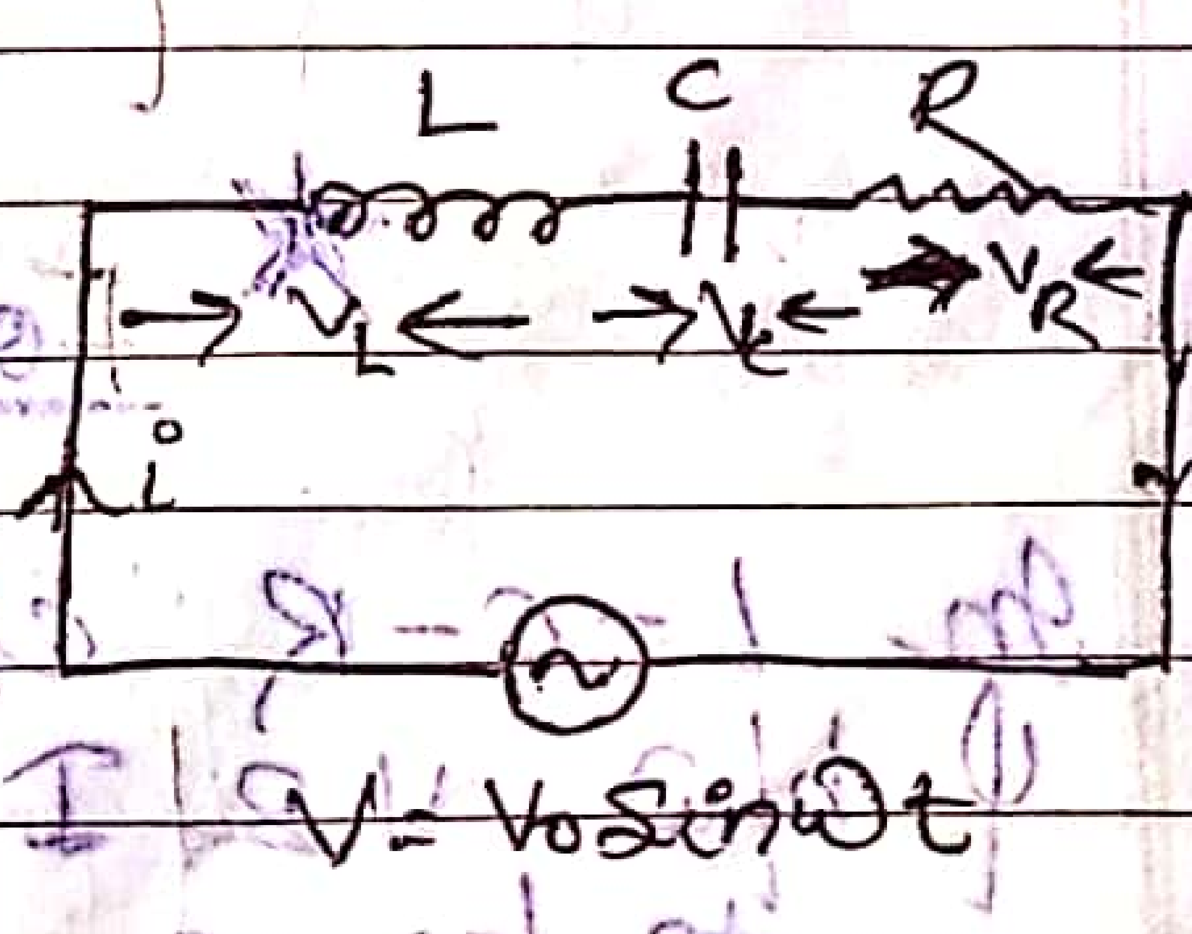
$$f = \sqrt{\frac{1}{4\pi^2 LC}}$$

$$\boxed{f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}}$$

f is called Resonance frequency

L-C-R CKt





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Resultant Potential of ckt

$$V^2 = V_R^2 + (V_L - V_C)^2 \qquad \because V_R = iR,\ V_L = iX_L,\ V_C = iX_C$$

$$V^2 = i^2R^2 + (iX_L - iX_C)^2$$

$$\frac{V^2}{i^2} = R^2 + (X_L - X_C)^2$$

$$\frac{V}{i} = \sqrt{R^2 + (X_L - X_C)^2}$$

$\frac{V}{i}$ is the impedance of ckt

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\boxed{Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

Let the phase difference b/w voltage and current is ϕ

$$\tan\phi = \frac{V_L - V_C}{V_R} = \frac{\cancel{i}X_L - \cancel{i}X_C}{\cancel{i}R}$$

$$\boxed{\tan\phi = \frac{\omega L - \frac{1}{\omega C}}{R}}$$

★ For electrical Resonance

In L-C-R ckt when phase difference ϕ b/w V & I then circuit is said to be a resonant ckt.

This is possible-

$$\omega L = \frac{1}{\omega C}$$

from

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

$$\boxed{Z = R}$$

In L-C-R ckt there will be electrical resonance when the impedance of the circuit will be equal to the resistance.

$$\omega L = \frac{1}{\omega C}$$

$$2\pi f L = \frac{1}{2\pi f C}$$

$$f^2 = \frac{1}{4\pi^2 LC}$$

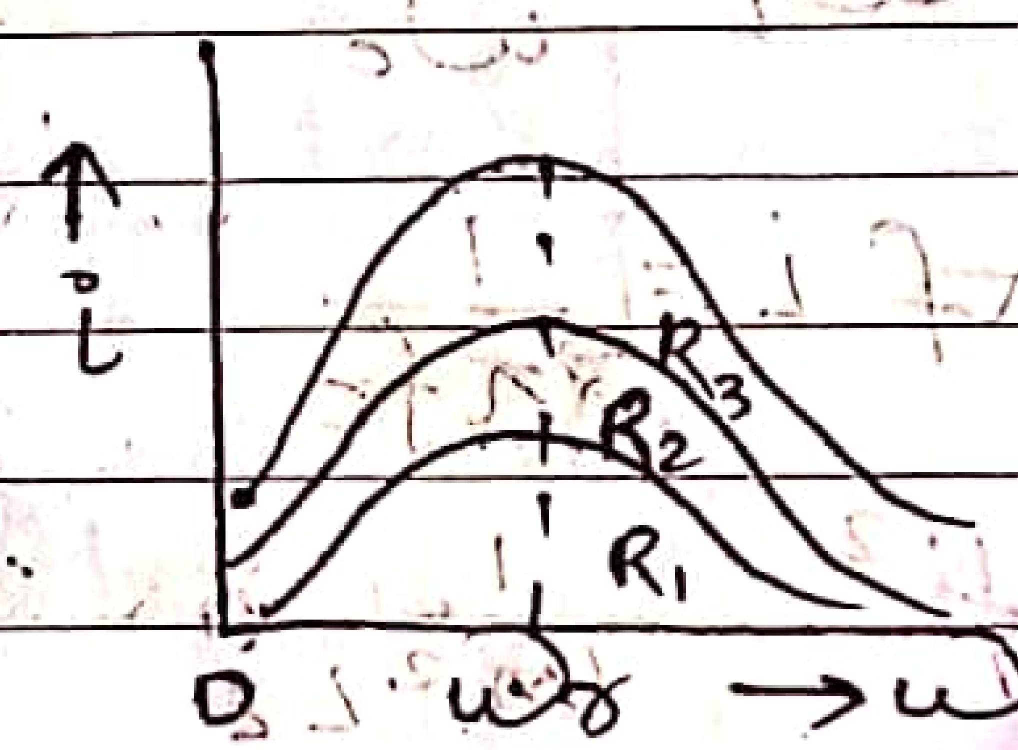
$$\boxed{f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}}$$

This frequency is called Resonance frequency.

The Sharpness of Resonance

- depend upon the quality factor of circuit
- The quality factor is the ratio of voltage develop across L or C & voltage across resistance.
- It is denoted by Q

$$\boxed{Q = \frac{\text{Voltage across L or C}}{\text{Voltage across R}}}$$



$R_1 > R_2 > R_3$

Average Power associated in AC circuit

$P = \frac{dW}{dt}$ —(1)

$P = Vi$ —(2)

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$\Rightarrow \frac{dW}{dt} = vi$

$dW = vi\,dt$

Let the phase diff. b/w voltage & current is ϕ

$dW = (V_0 \sin \omega t)(i_0 \sin(\omega t + \phi)\,dt$

Average workdone in one cycle.

$$W = \int_0^T dW = \int_0^T V_0 i_0 \sin \omega t \sin(\omega t + \phi)\,dt$$

$$W = V_0 i_0 \int_0^T \sin\omega t\,[\sin \omega t \cos\phi + \cos\omega t \sin\phi]\,dt$$

$$W = V_0 i_0 \int_0^T (\sin^2 \omega t \cos\phi + \sin\omega t \cos\omega t \sin\phi]\,dt$$

$$W = \frac{V_0 i_0}{2} \int_0^T [2\sin^2\omega t \cos\phi + 2\sin\omega t \cos\omega t \sin\phi]\,dt$$

$\because 2\sin\omega t \cos\omega t = \sin 2\omega t$

$$W = \frac{V_0 i_0}{2} \left[\int_0^T 2\sin^2\omega t \cos\phi\,dt + \int_0^T \sin 2\omega t \sin\phi\,dt\right]$$

$$W = \frac{V_0 i_0}{2} \left[\int_0^T (1+\cos 2\omega t)\cos\phi\,dt + \int_0^T \sin 2\omega t \sin\phi\,dt\right]$$

$$W = \frac{V_0 i_0}{2} \left[\int_0^T \cos\phi\,dt + \cos\phi \underbrace{\int_0^T \cos 2\omega t\,dt}_{0} + \sin\phi \underbrace{\int_0^T \sin 2\omega t\,dt}_{0}\right]$$

$\because \cos 2\omega t = 2\sin^2\omega t - 1$

$2\sin^2\omega t = \cos\omega t + 1$

$$W = \frac{V_0 i_0}{2} \times \cos\phi \,[t]_0^T \qquad \because \int_0^T \cos 2\omega t\, dt = 0$$

$$\Rightarrow W = \frac{V_0 i_0}{2} \times \cos\phi \times T \qquad \int_0^T \sin 2\omega t\, dt = 0$$

$$\bar{P} = \frac{W}{T} \Rightarrow \bar{P} = \frac{\frac{V_0 i_0}{2} \cos\phi \times \cancel{T}}{\cancel{T}}$$

$$\boxed{\bar{P} = \frac{V_0 i_0}{2} \times \cos\phi}$$

$$\bar{P} = \frac{V_0}{\sqrt{2}} \frac{i_0}{\sqrt{2}} \cos\phi$$

$$\boxed{P = V_{rms} \times i_{rms} \cos\phi}$$

Power factor

Average Power

$\cos\phi$ = Power factor

R-ckt

for R-ckt $\phi = 0$

$P_{av} = V_{rms} \times i_{rms} \cos 0$

$$\boxed{P_{av} = V_{rms} \times i_{rms}} \quad \text{(Power loss)}$$

L - ckt

$$\phi = \frac{\pi}{2}$$

$$\cos\phi = \cos \pi/2 = 0$$

$$\boxed{P_{av} = 0} \rightarrow \text{Wattless current}$$

"The current which consumes no power for its maintainence in ckt is called Wattless current"

C - ckt

$$\phi = \pi/2$$

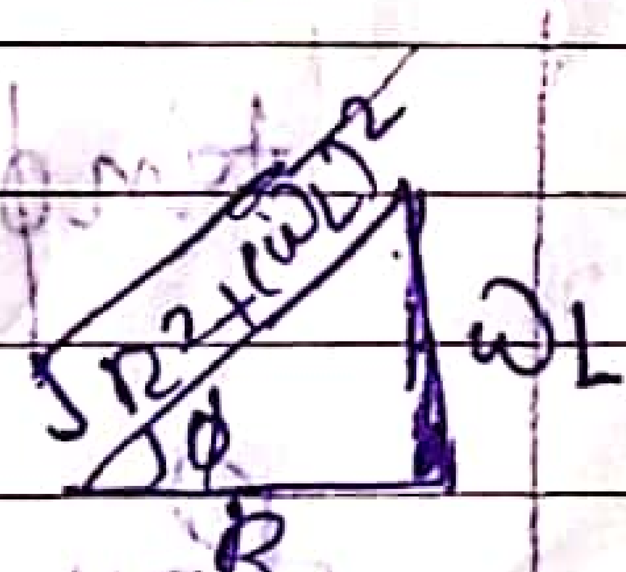
$$\cos\phi = 0$$

$$\boxed{P_{av} = 0} \rightarrow \text{Wattless current.}$$

Combination

L-R ckt

$$\tan\phi = \frac{\omega L}{R}$$



$$\cos\phi = \frac{R}{\sqrt{R^2+(\omega L)^2}}$$

$$P_{av} = V_{rms} \times i_{rms} \times \cos\phi$$

$$\left[P_{av} = V_{rms} \times i_{rms} \times \frac{R}{\sqrt{R^2 + (\omega L)^2}} \right]$$ (Power loss)

For $\underline{C-R}$ $\underline{ckt}$

$$\tan\phi = \frac{1}{\omega CR}$$

$$\tan\phi = \cos\phi = \frac{\omega CR}{\sqrt{1+(\omega CR)^2}}$$

$$P_{av} = V_{rms} \times I_{rms} \times \frac{\omega CR}{\sqrt{1+(\omega CR)^2}}$$

In L-C Ckt

$\cancel{\tan\phi}$

$\phi = \pi/2$

$\cos\phi = 0$

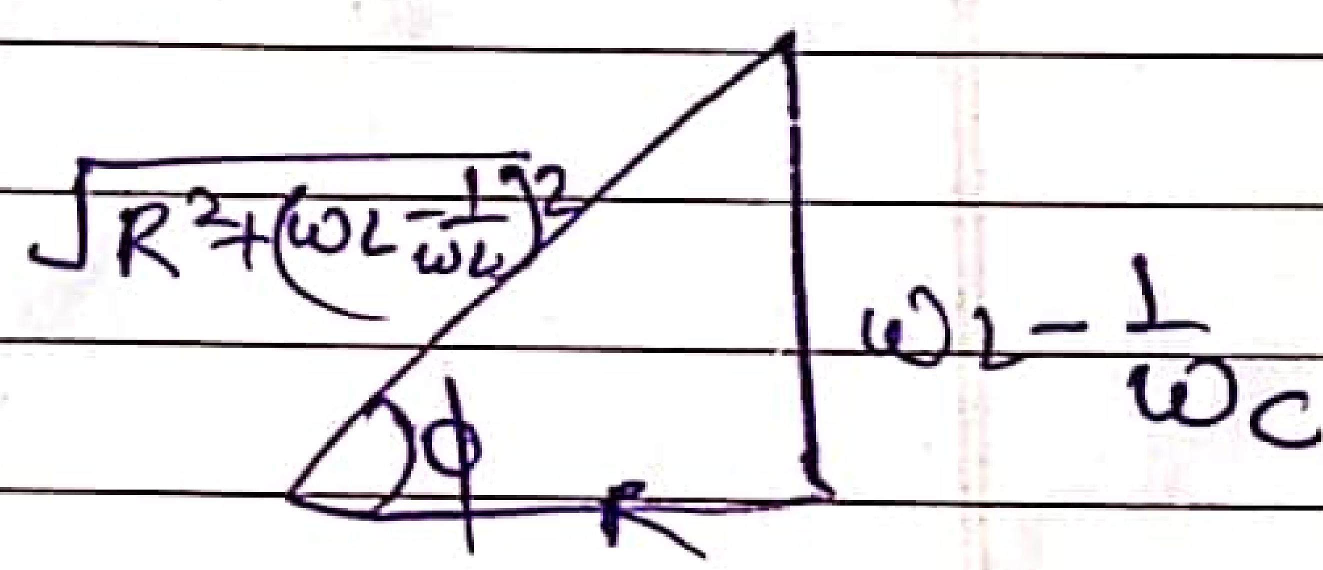
$P_{av} = i_{rms} \times V_{rms} \times \cos\theta$

$$\boxed{P_{av} = 0}$$

[Wattless current]

In L-C-R Ckt

$$\tan\phi = \frac{\omega L - \frac{1}{\omega C}}{R}$$



$\cancel{P_{av} = V_{rms} \times i_{rms}}$

$$\cos\phi = \frac{R}{R^2 + (\omega L - \frac{1}{\omega C})^2}$$

$$\boxed{P_{av} = V_{rms} \times i_{rms} \times \frac{R}{\sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}}}$$

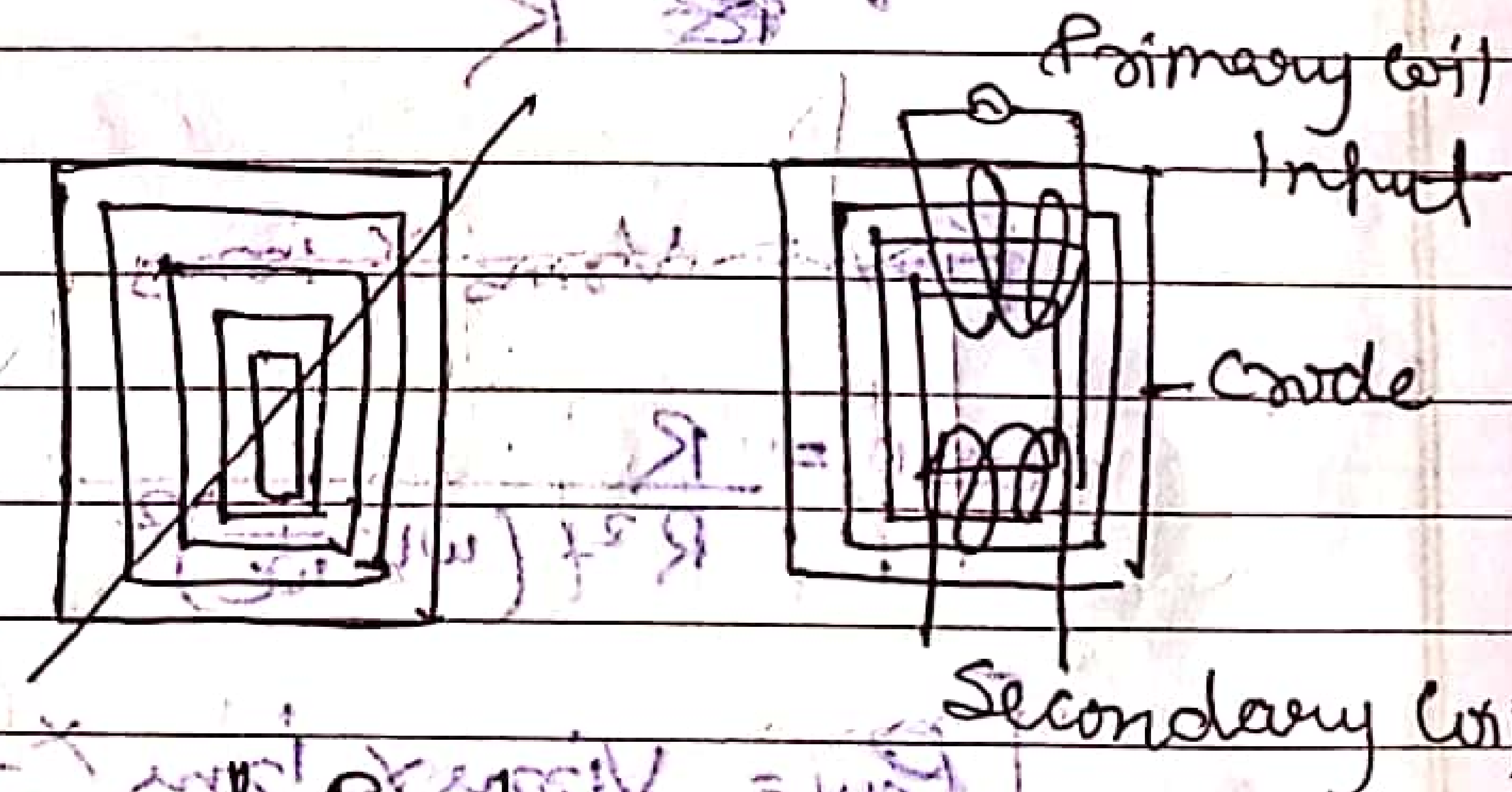
TRANSFARMER

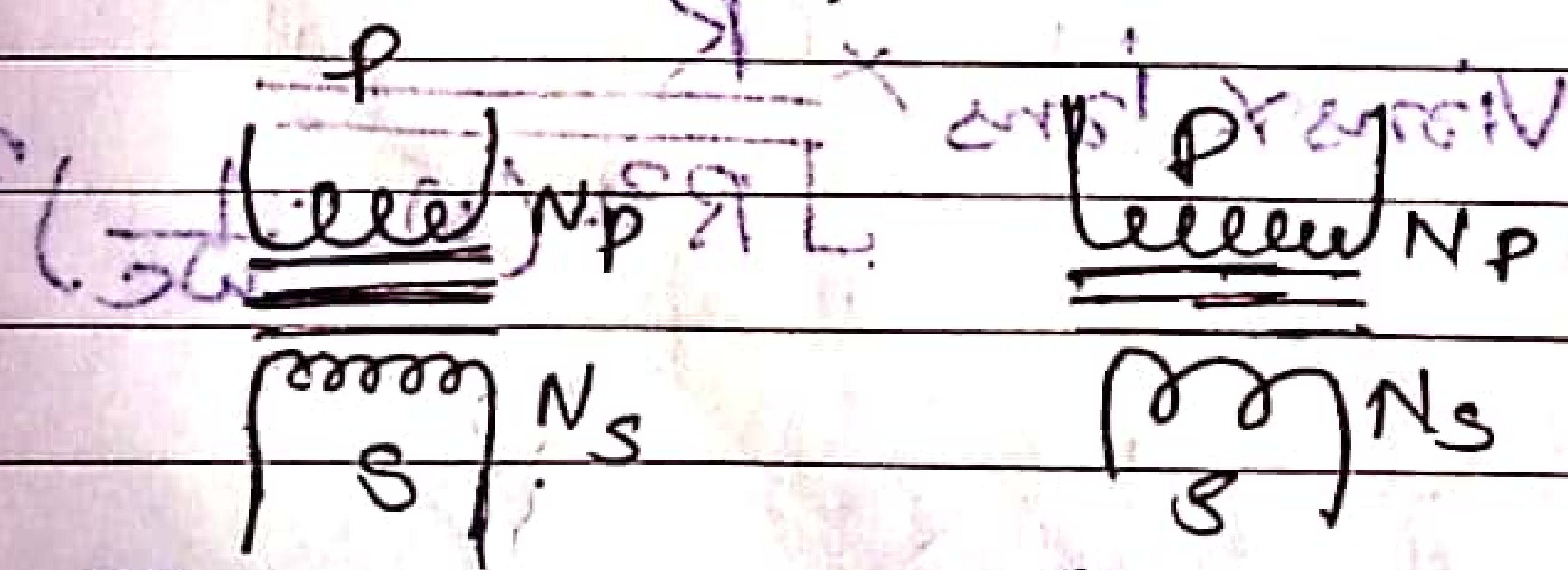
- It is a device which increase or decreased A.C voltage.

- Kind of Transfarmer
  - i) Step-up Transfarmer
  - ii) Step-down "

- Principle → Transfarmer is based upon mutual inductance

- Construction → It consist two coil primary coil (p) and secondary coil (s) wounds and separated on a soft Iron Core.





Step-up
$(N_S > N_P)$

(Step down)
$(N_S < N_P)$

Ideal transformer

A transformer which the primary coil has negligible resistance and all the flux in the core links both primary and secondary coil.

Working and Theory

Let the No. of turns in primary coil is N_P and of secondary coil is N_S

then the induced e.m.f in primary coil

$$e_P = -N_P \frac{d\phi}{dt} \quad \text{—①}$$

and induced e.m.f in secondary coil

$$e_S = -N_S \frac{d\phi}{dt} \quad \text{—②}$$

② ÷ ①

$$\boxed{\frac{e_S}{e_P} = \frac{N_S}{N_P}}$$

If the voltage across primary coil is V_P and on secondary coil is V_S

then-

$$\boxed{\frac{e_s}{e_p} = \frac{V_s}{V_p} = \frac{N_s}{N_p} = r}$$

Where r is Transformer Ratio

i. If $r > 1$ Step-up ~~Transf~~ Transformer

ii. If $r < 1$ Step down Transformer.

★ Why $N_s > N_p$ for step up Trans

$$\frac{N_s}{N_p} > 1$$

$$N_s > N_p$$

For step down

$$\frac{N_s}{N_p} < 1$$

$$N_p > N_s$$

Energy Losses in a Transformer

There are some energy losses in a transforms

(*i*) **Eddy Current Loss** Eddy current in iron core of transformer facilitate the loss of energy in the form of heat.

(*ii*) **Flux Leakage** Total fluxes linked with primary do not completely pass through the secondary which denotes the loss in the flux or flux leakage.

(*iii*) **Copper Loss** Due to heating, energy loss takes place in copper wires of primary and secondary coils.

(*iv*) **Hysteresis Loss** The energy loss takes place in magnetising and demagnetising the iron core over every cycle.

(*v*) **Humming Loss** The magnetostriction effect leads to set the core in vibration which in turn produced the sound. This loss is referred as humming loss.

Efficiency of Transformer

The ratio of output power and input power is called efficiency of Transformer.

It is denoted by – η

$$\boxed{\eta = \frac{\text{output power}}{\text{Input power}}}$$

If the efficiency of Transformer is 100% then power at primary coil will be equal to the power at secondary coil.

Power at Primary coil = Power at secondary coil

$$V_p \times i_p = V_s \times I_s$$

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$$\left[\frac{V_s}{V_p} = \frac{i_p}{i_s}\right]$$

So,

$$\left[\frac{e_s}{e_p} = \frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{i_p}{i_s} = r\right]$$

Choke Coil

It is based upon self Induction
↓
It is used in A.C. ckt to control current without loss of power.

$$P = V_{rms} \times i_{rms} \cos\phi$$

i. For Resistance

$$\phi = 0$$

$$[P_{rms} = V_{rms} \times i_{rms}]$$

(Powerloss) Therefore we can't use Resistance

ii. In Inductance $\theta = 90°$

$$P = V_{rms} \times i_{rms} \cos 90°$$

$$[P = 0]$$

[Rehostate – D.C
choke coil – A.C]

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