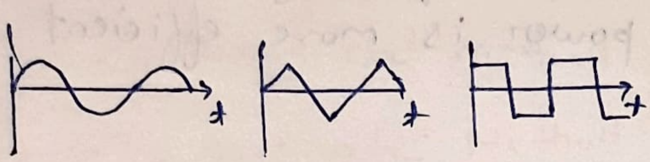
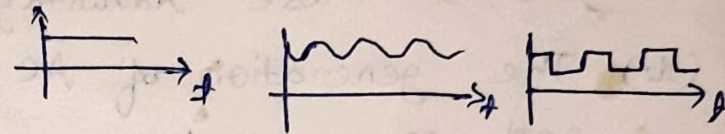
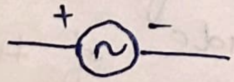
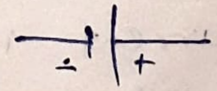
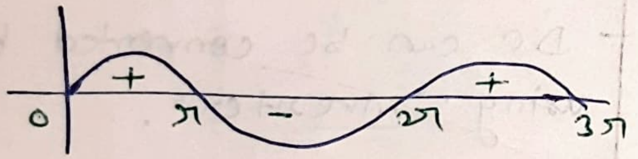
* Unit - 2 *

Singal Phase AC Current

- Difference b/w AC & DC.

* Alternating Current	* Direct Current
1. V & C change it's polarity periodically. 	V & C polarity remains constant 
2. Energy loss is less	Energy loss is more
3. Less powerfull as it becomes max for few times.	more powerful as it is always max & travel with full speed.
4. transmitted upto a long distance	Cann't be transmitted upto long distance
5. AC can be converted into DC by using "Rectifier"	DC can be converted by using "Inverter".
6. Low cost.	High cost.
7. Frequqncy is arround 50Hz - 60Hz	Frequency is zero
8. AC motor & other AC appliancen more durable & Robust.	DC motor & other DC appliances less durable & roblust.
9. 	

So AC circuit are electrical circuits which are operated by AC energy sources such as alternate.
→ these circuits are more complicated than DC circuits. Due to there time varing factors, we mostly use AC systems.
AC systems offers many advantages over DC systems. These Advantages are following:
(1.) The generation of AC power is more efficient and economical.
(2) The AC voltage can easily step-up & step down.
(3) The AC motors are less expensive & more efficient.
(4.) The AC System are used for generation, transmission & distribution of electrical power.



positive ⇒ 0 to π
Negative ⇒ π to 2π

→ AC current may define as a current whose magnitude changes periodically with time.
AC Cycle consists two parts, first positive half and second negative half.

Instantaneous value Insto value of an AC current is the magnitude of the AC current instant or particular time.

$$\left(I = \frac{dq}{dt} = I_{nst} \right)$$

• **Average Value :-** The avg value of an AC quantity is define as the avg of all instantenuous value of the AC quantity over one cycle.

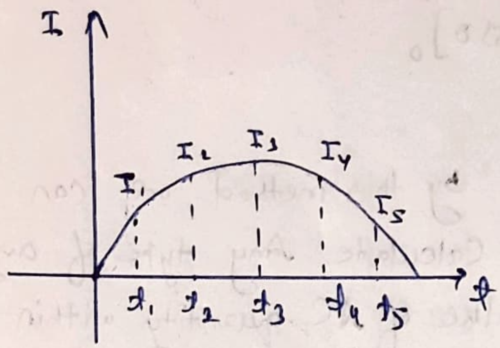
For calculate avg value, following methods are used -

(i) Mid Ordinate Method

(ii) Analytical method

(i) Mid ordinate Method :-

$$I_{av} = \frac{\Sigma I_n}{n}$$



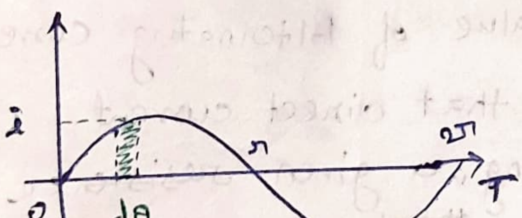
$$\boxed{I_{av} = \frac{I_1 + I_2 + I_3 + \dots I_n}{n}}$$

Here n is total number of time interval.

and $I_1, I_2, I_3 \dots I_n$ are insto value of current of particular time interval.

$$\left[I_{av} = \frac{\text{Area of Power}}{\text{Base}} \right]$$

(ii) Analytical Method :-



In this method, we consider a strip of thickness of $d\theta$ and the ordinate for the strip will be i.

$i = I_m \sin\theta$

Area of the strip

$dA = i\,d\theta$

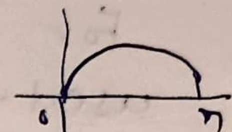
A of Half cycle can be findout by

$$\because \int dA = \int_0^{\pi} i\,d\theta \quad \text{—(i)}$$

$$A = \int_0^{\pi} i \, d\theta \qquad [\because i = I_m \sin\theta]$$

$$\Rightarrow A = \int_0^{\pi} I_m \sin\theta \, d\theta \quad \text{—(ii)}$$

$$\Rightarrow \cancel{A} \quad \because I_{av} = \frac{\text{Area of Half wave}}{\text{Base of Half wave}}$$



Base = $\pi - 0$

Area

$$I_{av} = \frac{\int_0^{\pi} I_m \sin\theta \, d\theta}{\pi - 0}$$

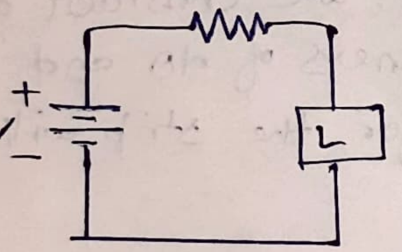
$$I_{av} = \frac{I_m}{\pi} [\cos\theta]_0^{\pi}$$

$$\boxed{I_{av} = -\frac{2}{\pi} I_m}$$

By this method we can Calculate Any type of avg value of AC quantity within any time period.

• RMS Value [Root mean Square]:-

→ The RMS value is effective value of an AC quantity.

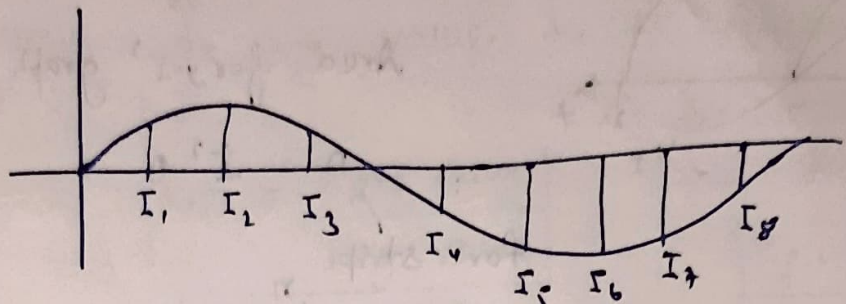


(Circuit)

The Rms value of Alternating current is equal to that direct current which is flowing through a given ~~resistence~~ resistive circuit for a given time interval, produces same heat as produced by the alternating current when flowing through the same circuit for the same duration of time.

We have two methods to find RMS value.

(i) Mid ordinate method :-



When AC flows through a conductor with R resister.

$$H_1 = \frac{I^2 R t}{J n}$$

$$H_n = \frac{1}{J n}[I_n^2 R t_n]$$

for all time period

$$H_{AC} = \frac{1}{J}\left[\frac{I_1^2 R t_1}{n} + \frac{I_2^2 R t_2}{n} + \frac{I_3^2 R t_3}{n} + \dots \frac{I_n^2 R t}{n}\right]$$

$$(t_1 = t_2 = \dots = t_n)$$

$$H_{AC} = \frac{R t}{J}\left[\frac{I_1^2 + I_2^2 + \dots + I_n^2}{n}\right]$$

When DC flows through that same circuit

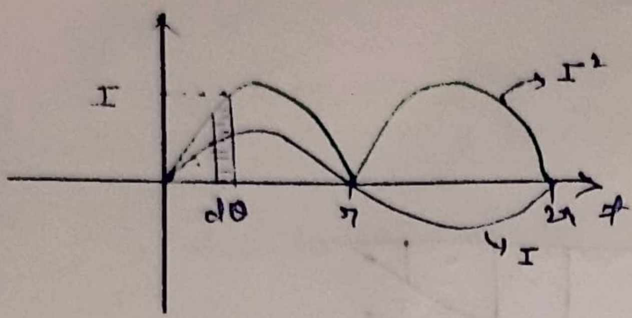
$$H_{DC} = \frac{I^2 R t}{J}$$

for rms value $H_{AC} = H_{DC}$

$$\frac{I_{rms}^2 R t}{J} = \frac{R t}{J}\left[\frac{I_1^2 + I_2^2 + \dots + I_n^2}{n}\right]$$

$$\boxed{I_{rms} = \sqrt{\frac{I_1^2 + I_2^2 + \dots + I_n^2}{n}}}$$

(ii) Analytical Method:-



$\because I = I_m \sin\theta$

$I^2 = I_m^2 \sin^2\theta$

Area for y. I^2 graph

$A = I^2 . \theta$

for strip

$dA = \int_0^{\pi} I^2 d\theta$ [over the half cycle]

$I_{rms}^2 = \dfrac{\int_0^{\pi} i^2 d\theta}{t_2 - t_1}$

$\left(\because \sin^2\theta = \dfrac{1-\cos 2\theta}{2}\right)$

$I_{rms}^2 = \dfrac{\int_0^{\pi} I_m^2 \sin^2\theta \, d\theta}{\pi - 0}$

$I_{rms}^2 = \dfrac{I_m^2}{\pi} \int_0^{\pi} \left(\dfrac{1-\cos 2\theta}{2}\right) d\theta$

$I_{rms}^2 = \dfrac{I_m^2}{\pi} \left[\dfrac{\theta}{2} - \dfrac{\sin 2\theta}{4}\right]_0^{\pi}$

$I_{rms}^2 = \dfrac{I_m^2}{\pi} \left[\dfrac{\pi}{2}\right]$

$I_{rms}^2 = \dfrac{I_m^2}{2}$

$$\boxed{I_{rms} = \dfrac{I_m}{\sqrt{2}}}$$

★ Formula for given time Period

$I_{avg} = \dfrac{\int_{t_1}^{t_2} i\,dt}{\int_{t_1}^{t_2} dt}$

★ for Full cycle

$I_{avg} = 0$ (0 to 2π)

★ for half cycle ⊕ (0 to π)

$I_{avg} = \dfrac{2I_m}{\pi}$

⊖ (π to 2π)

$I_{avg} = -\dfrac{2I_m}{\pi}$

I_{avg} for half wave ractifire $= \dfrac{1}{2}(I_{avg}$ of half cycle$)$

$\boxed{I_{avg} = 0.318 I_m}$

• Form Factor (KF) :-

Form factor represents the relation between Rms value & avg value. It is defined as the ratio of rms value to avg. value to AC quantity. It is denoted by K.F.

$$\boxed{K.F. = \frac{\text{Rms value}}{\text{Avg value}}}$$

for sinusodial varying current

$\boxed{K_f = 1.11}$

• Peak Factor (KP) :-

It is defined as the ratio of max value to Rms value of AC quantity. It is denoted by Kp

$$\boxed{K_p = \frac{\text{max value}}{\text{Rms value}}}$$

for sinusodial varying current

$\boxed{K_p = 1.414}$

Terminology of AC Waves :-

$I = I_m \sin(\omega t + \theta)$ [Sinusodial wave form]

I — Inst current value of AC quantity.

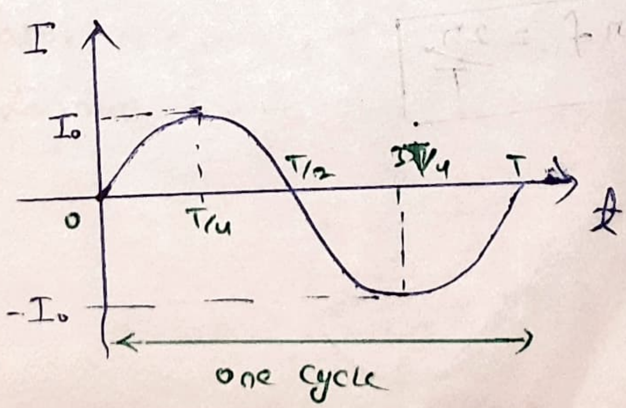
I_m — max Current

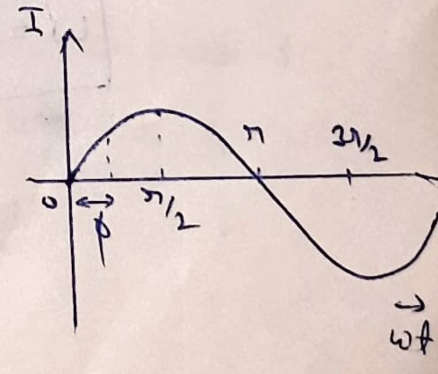
$(\omega t + \theta)$ — Angular representation.

$\omega \Rightarrow$ Angular frequency

$t \rightarrow$ time

$\theta \rightarrow$ Phase angle.





(i) Wave form: A curve obtain by plotting ints value against time is called wave form of AC Quantity.

(ii) Time Period: The time of completing one cycle of the AC wave is called it's time period.

During the time 0 to 2π wave chage it's angle

$$\omega T = 2\pi$$

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

(iii) Frequency: Frequency is the number of cycle that accurs in one second.

unit ⇒ Hz ($1/sec$)

$$\boxed{f = \frac{1}{T}}$$

(iv) Amplitude: The maximum positive or negative value of an alternating quantity is called Amplitude.

[Max displacement from axis]

(v) Cycle: The value of Sine wave repeat after 2π radians. one complete set of positive & negative value of the function is called a cycle.

(vi) Anguler Frequency: Angular frequency (ω) is equal to the number of radian covered in one seconds.

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

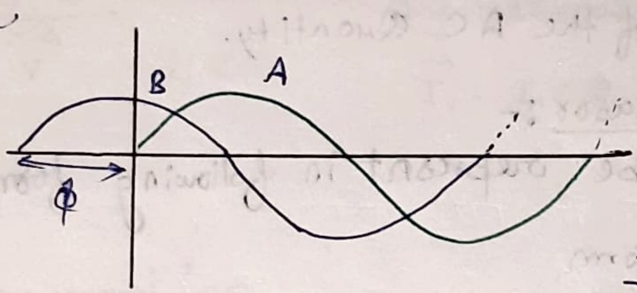
(vii) **Phase:** Phase is the fraction of the time period or cycle that has elapsed since it last passed from the choosen origin.

Phase angle is angular displacement from a refrence point. (Angular component of periodic wave)

$$\boxed{\phi = \frac{2\pi t}{T}}$$

(vii) **Phase Difference:** This term is used to compare to phase of two alternating quantity.

It is a measurement in a degrees of How much one wave lead another wave or ~~long~~ lag behind that wave.



$I_A = I_{m_1} \sin \omega t$

$I_B = I_{m_2} \sin(\omega t + \phi)$.

* Phase Representation of AC Quantity:

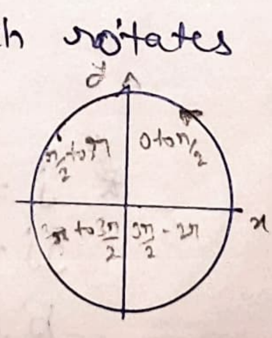
A phasor is a complex number used to represent the magnitude and phase of a sinusodial function.

A phasor is a line of definite length rotating in a anticlockwise direction at a constant angular valocity ω.

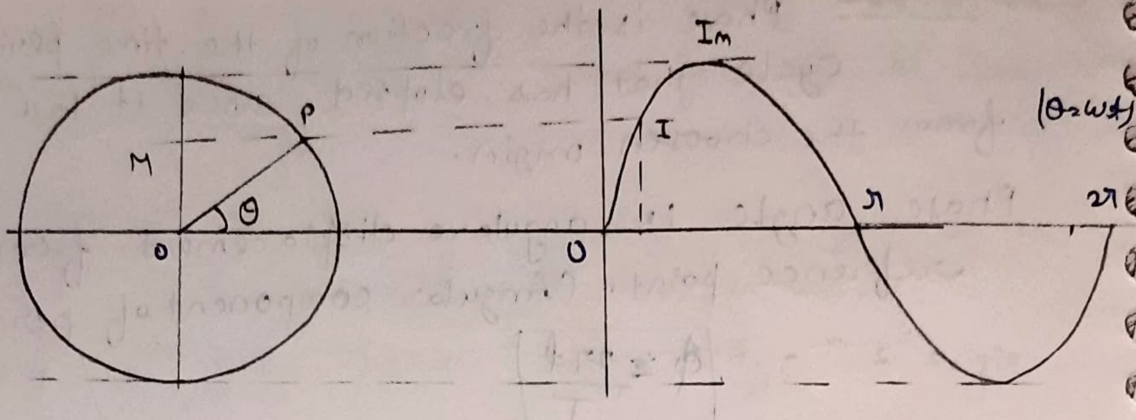
Length of phasor line = max value of AC

That has both megnitude & direction.

In A phasor diagram, the phasor's are represented by Arrows which rotates with angular frequency of ω.



Anticlock



★ **Properties of Phasor**

(i) The length of a phasor is proportional to the max value of the AC Quantity.

(ii) The projection of a phasor on the vertical axis gives the inst. value of the AC Quantity.

★ **Diff form of Phasor :-**

A phasor can be represent in following forms -

(i) Rectangular form
(ii) Trignometrical form
(iii) Polar form
(iv) Exponential form.

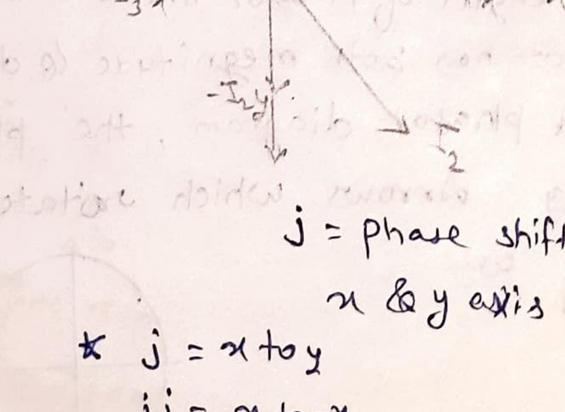
(1) **Rectangular form**

$\vec{V} = a + jb$

magnitude of phase

$|\vec{V}| = \sqrt{a^2+b^2}$

$\phi = \tan^{-1}(b/a)$



Ex

for $I_1 = I_1x + jI_{1y}$

$I_2 = I_2x - jI_{2y}$

$I_3 = -I_{3x} + jI_{3y}$

j = Phase shift b/w x & y axis

★ j = x to y

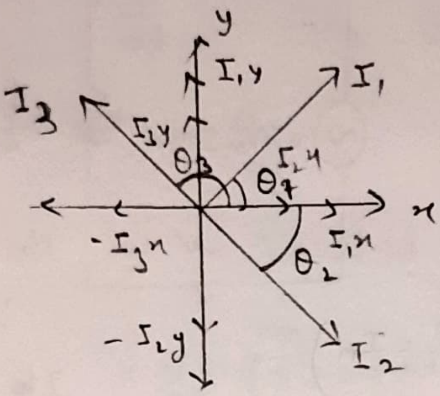
jj = x to -x

jjj ⇒ x to -y

★ **Trigonal form**

$a = v\cos\phi, \; b = v\sin\phi$

$\vec{v} = v(\cos\phi + j\sin\phi)$



Ex

$I_1 = I_1\cos\theta_1 + jI_1\sin\theta_1$

$I_2 = I_2\cos\theta_2 - jI_2\sin\theta_2$

$I_3 = -I_3\cos\theta_3 + jI_3\sin\theta_3$

★ **Polar form**

$\vec{v} = |\vec{v}| \angle\phi$

by previous ex

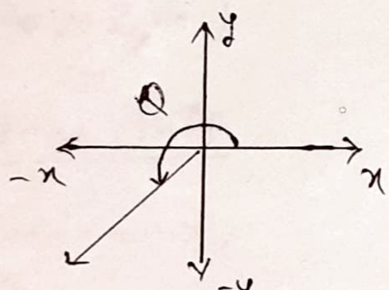
$\vec{I_1} = I_1\angle\theta_1$, $\vec{I_2} = I_2\angle\theta_2$

$\vec{I_3} = I_3\angle\theta_3$

Note Exponential form

$\vec{I_1} = I_1 e^{j\theta_1}$; $\vec{I_2} = I_2 e^{j\theta_2}$; $\vec{I_3} = I_3 e^{j\theta_3}$

Q



$I_1 = -I_1\cos 240° - I_1\sin 240° j$

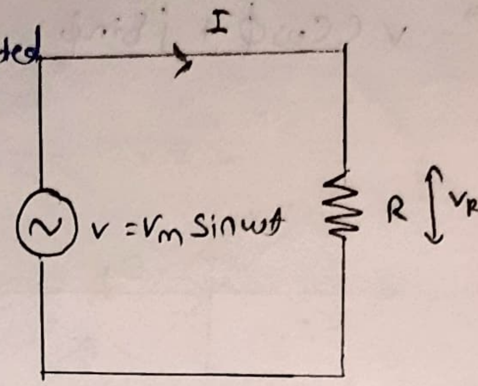
$I_1 = +0.5 I_1 + 0.86 j I_1$

$\theta = 240°$

AC Circuits

(i) AC Circuit with Pure Resistence (R) :-

Consider a pure resistor R connected across an alternating voltage source.



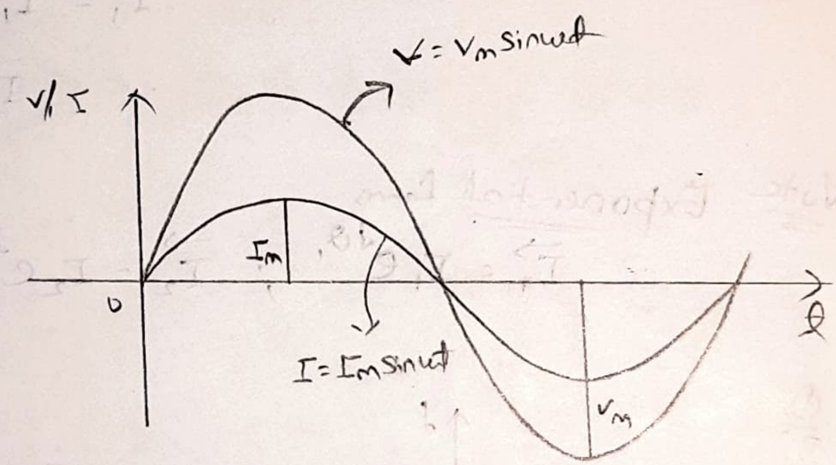
(i)
$$I = V/R = \frac{V_m \sin\omega t}{R}$$

$$I = I_m \sin\omega t \quad \left(\text{where } \frac{V_m}{R} = I_m\right)$$

(ii) $Z = \frac{V}{I} = \frac{V_m/\sqrt{2}}{I_m/\sqrt{2}} = \frac{V_m}{I_m}$ (Impendance)

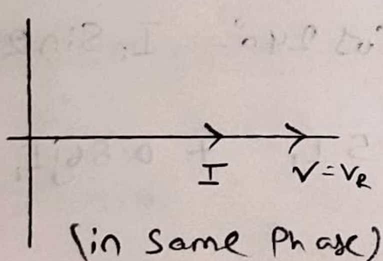
$$Z = \frac{V_m}{V_m/R}$$

$$\boxed{Z = R}$$



(iii) Phase Diff

$$\boxed{\phi = 0°}$$



(in same phase)

(iv) Power Consumed $P = VI$

$$P = V_m \sin\omega t \, (I_m \sin\omega t)$$

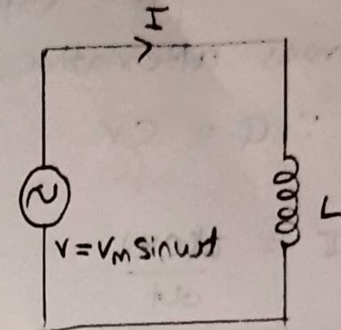
$$P = V_m I_m \sin^2\omega t$$

$$P = \frac{V_m I_m}{2}(1 - \cos 2\omega t)$$

Average Power $\boxed{P_{av} = \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}} = VI}$

(ii) AC Circuit with Pure Inductor :-

Consider a pure inductor L connected with an alternating voltage source.



$$V = L\frac{dI}{dt} \qquad \because V = V_m \sin\omega t$$

$$V_m \sin\omega t = L\frac{dI}{dt}$$

$$dI = \frac{V_m}{L}\sin\omega t\, dt$$

$$dI = \frac{V_m}{L}\int \sin\omega t\, dt$$

$$I = \frac{V_m}{\omega L}\cos\omega t$$

(Let $\omega L = X_L$)

$$I = I_m \sin(\omega t - \pi/2)$$

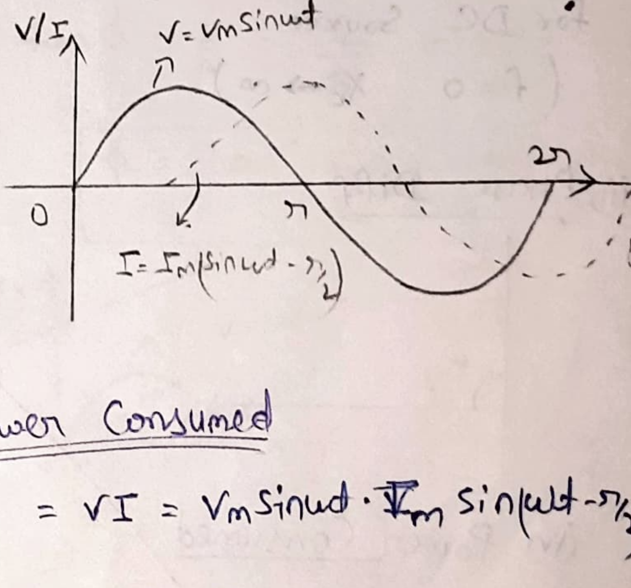
$$\left(I_{max} = \frac{V_m}{\omega L} = \frac{V_m}{X_L} \right)$$

(ii) Impendance

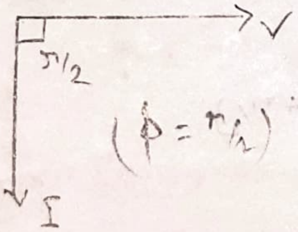
$$\boxed{Z = X_L = \omega L}$$

unit = ohm

(for DC
$f = 0 \Rightarrow X_L = 0$)



(iii) Phase Diff



$(\phi = \pi/2)$

(iv) Power Consumed

$$P = VI = V_m\sin\omega t \cdot I_m \sin(\omega t - \pi/2)$$

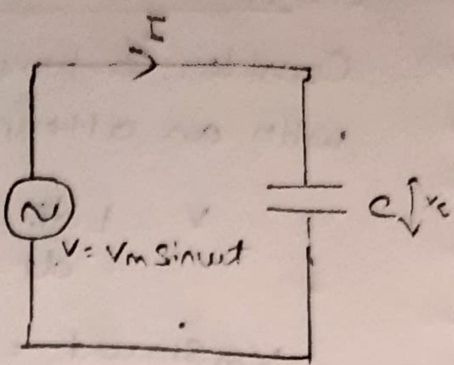
$$P = \frac{V_m I_m \sin\omega t \cos\omega t \times 2}{2}$$

$$P = \frac{V_m I_m \sin 2\omega t}{2}$$

or $$\boxed{P = \frac{V_m^2 \sin 2\omega t}{2X_L}}$$

(iii) AC Circuit with Pure Capacitance :-

Consider a pure Capacitor C connected across alternative voltage Source.



$\because Q = CV$

$$I = \frac{dq}{dt}$$

(i)

$$I = \frac{d(CV)}{dt}$$

$$I = \frac{C\,d(V_m \sin\omega t)}{dt}$$

$$I = \omega C V_m \cos\omega t$$

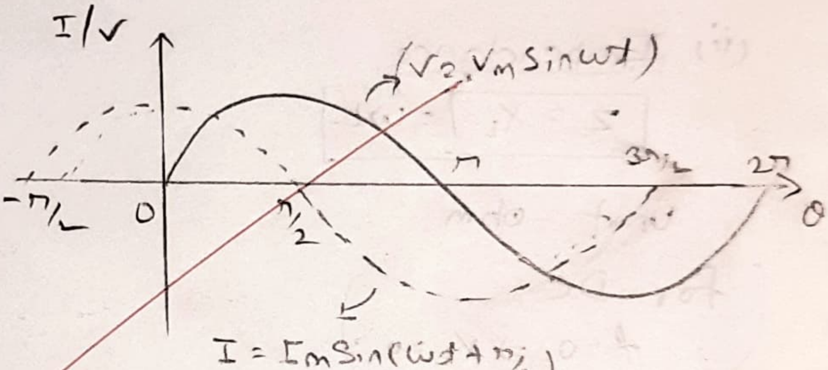
$$I = \frac{V_m}{1/\omega C} \sin(\omega t + \pi/2)$$

$$\boxed{I_c = \frac{V_m}{X_c} \sin(\omega t + \pi/2)}$$

let $\frac{1}{\omega C} = X_c$

(ii) (Capacitive impendance)

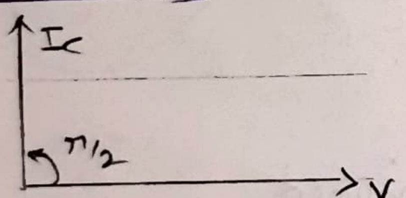
$$\left(I_{max} = \frac{V_m}{X_c} = V_m \times \omega C \right)$$



for DC Source

$(f = 0 \quad X_L \to \infty)$

(iii) Phase Diff



(iv) Power Consumed

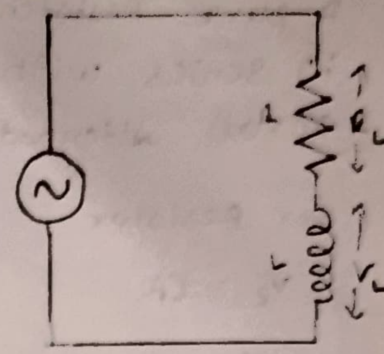
$$P = VI = V_m \sin\omega t \cdot I_m \sin(\omega t + \pi/2)$$

$$P = V_m I_m \sin\omega t \cos\omega t$$

$$\boxed{P = \frac{V_m I_m}{2} \sin 2\omega t}$$

(iv) A.C Circuit with R-L :-

A pure resistor R connected with in series with a pure inductor L across an alternating voltage Source (V)



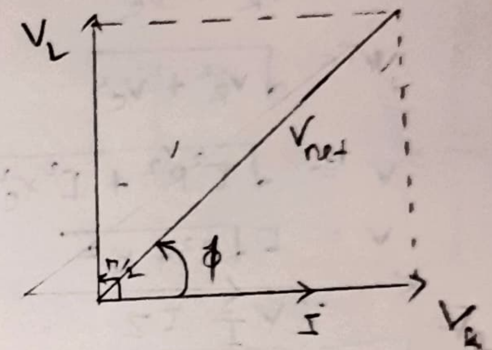
for Resistor

$V_R = IR$

for Inductor

$V_L = I X_L$

$V_{tot} = \vec{V} = \vec{V}_R + \vec{V}_L$



$\cancel{I(R+X_L)}$

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

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

$\because V = I \cdot Z$

$IZ = I\sqrt{R^2 + X_L^2}$

$\boxed{Z = \sqrt{R^2 + X_L^2}}$

(ii) Impendence

$(\vec{Z} = R\hat{i} + X_L\hat{j})$

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

$\boxed{\phi = \tan^{-1}\left(\frac{X_L}{R}\right) = \tan^{-1}\left(\frac{\omega L}{R}\right)}$

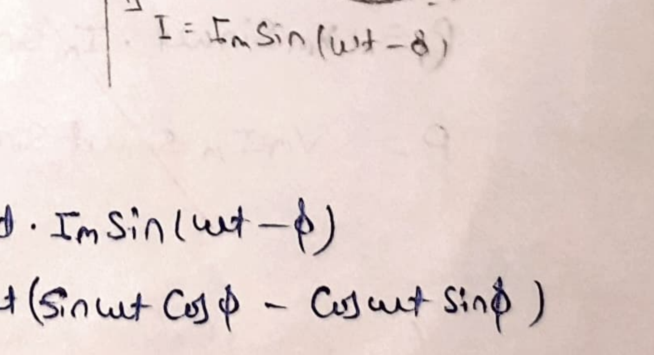
(i) Current

$I_m = \frac{V_m}{Z}$

$I = I_m \sin(\omega t - \phi)$

(iii) Phase diff =

$\phi = \tan^{-1}\left(\frac{X_L}{R}\right)$



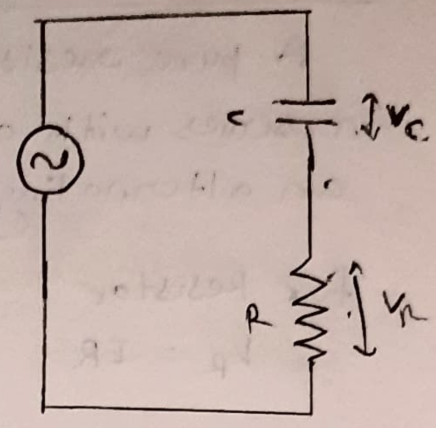
(iv) Power Consumed

$P = VI = V_m \sin\omega t \cdot I_m \sin(\omega t - \phi)$

$P = V_m I_m [\sin\omega t(\sin\omega t \cos\phi - \cos\omega t \sin\phi)$

(v) AC circuit with R - C :-

A pure Resistence R connected with in series with a pure capicitor across Alternating source.



for Resistor

$V_R = IR$

for Capicitor

$V_C = I X_C$

(i) $\vec{V} = \vec{V_R} + \vec{V_C}$

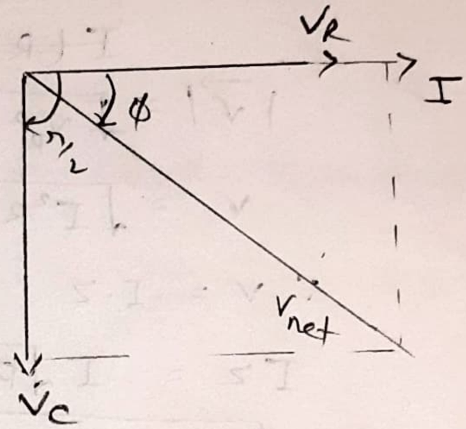
$V = \sqrt{V_R^2 + V_C^2}$

$V = \sqrt{I^2R^2 + I^2X_C^2}$

$V = I\sqrt{R^2 + X_C^2}$

$\because V = IZ$

$\boxed{Z = \sqrt{R^2 + X_C^2}}$ (Impendance)



(ii) Phase Diff

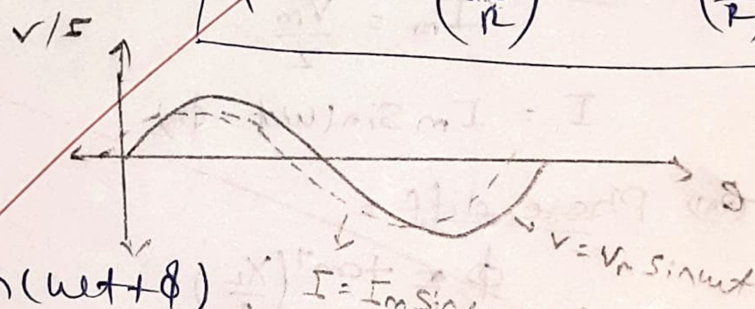
$\tan\phi = \frac{L}{R} = \frac{V_C}{V_R} = \frac{X_C}{R}$

$\boxed{\phi = \tan^{-1}\left(\frac{X_C}{R}\right) = \tan^{-1}\left(\frac{V_C}{R}\right)}$

Current

$I = I_m \sin(\omega t + \phi)$

$\left(I_m = \frac{V_m}{Z}\right)$



(iii) Power Consumed

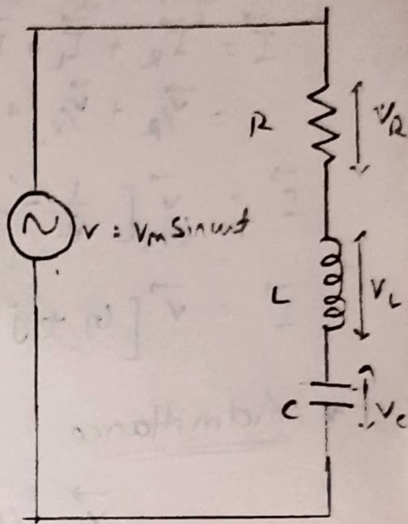
$P = VI$

$P = V_m \sin\omega t \cdot I_m \sin(\omega t + \phi)$

$P = V_m I_m \sin\omega t \sin(\omega t + \phi)$

(vi) AC Circuit with L.C.R. :-

A pure Resistance, and a pure capicitor connected ~~with~~ in series with a pure inductor(L). across Alternating source.

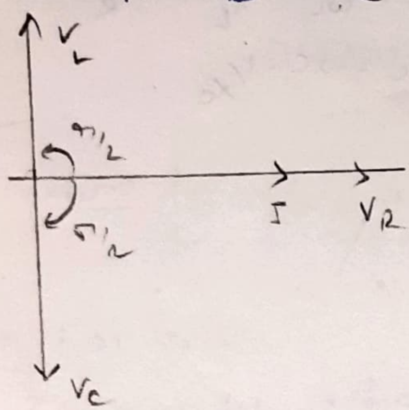


For Resistor $V_R = IR$

for Capicitor $V_C = IX_C$

for Inductor $V_L = IX_L$

(i) $\vec{V} = \vec{V_R} + \vec{V_L} + \vec{V_C}$



Phase Diff

$$\theta = |X_L - X_C|$$

$$\tan\phi = \frac{\theta}{R} = \frac{X_L - X_C}{R}$$

$$\tan\phi = \frac{X_L - X_C}{R}$$

$$\boxed{\phi = \tan^{-1}\left(\frac{|X_L - X_C|}{R}\right)}$$

(ii) Impedance

$$\vec{V} = \vec{V_R} + \vec{V_L} + \vec{V_C}$$

$$\cancel{V = \vec{V_R} + \vec{V_L}}$$

$$\vec{V} = \vec{I}R + j\vec{I}X_L - jX_C\vec{I}$$

$$\vec{V} = \vec{I}\,[R + (X_L - X_C)j]$$

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

$$V = I.Z$$

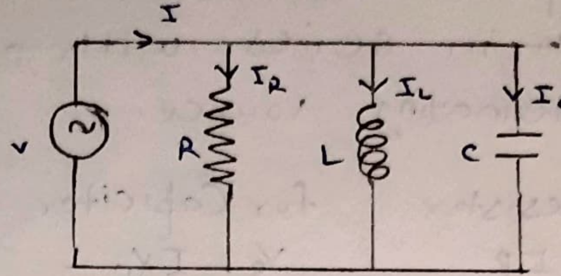
$$\boxed{Z = \sqrt{R^2 + (X_L - X_C)^2}}$$

(iii) Current :- $V_m = V_m \sin\omega t$ then $I = I_m \sin(\omega t \pm \phi)$

→ + when $X_C > X_L$ → Current leads

⇒ − when $X_L > X_C$ → Current Lags

Note For Parallel Seat, Connection



Apply 'KCL'

$$\vec{I} = \vec{I_R} + \vec{I_L} + \vec{I_C}$$
$$= \vec{V}/R + \vec{V}/X_L + \vec{V}/X_C$$
$$\vec{I} = \vec{V}\left[\frac{1}{R} - \frac{j}{X_L} + \frac{j}{X_C}\right]$$
$$\vec{I} = \vec{V}\left[G + j(B_C - B_L)\right]$$

$$\left[\begin{array}{ll} B_L = \frac{1}{\omega L} = 1/X_L & 1/R = G \\ B_C = \omega C = 1/X_C & \end{array}\right]$$

* Admittance

$$\vec{Y} = (G + j(B_C - B_L))$$

* Phase Angle

$$\phi = \tan^{-1}\left(\frac{B_C - B_L}{G}\right)$$

- Real Power :-

In a Simple ac Circuit consisting of a Source & load, both the current & voltage are sinousoidal. If the load is purely resistive, the produce of voltage & current at every instant is positive.

$$\boxed{\begin{array}{l} P = V_{rms} I_{rms} \cos\phi \\ P = I_{rms}^2 R \end{array}}$$

unit = watt

- Reactive Power :-

It is the power developed in the inductive reactance of the circuit.

$$\boxed{\begin{array}{l} Q = V_{rms} I_{rms} \sin\phi \\ Q = I_{rms}^2 X_L \end{array}}$$

unit = Volt-ampere-reactive.

* Apparent Power

It is given by the product of rms value of applied voltage & circuit current -

unit ⇒ Volt Amp (VA)

$$\boxed{S = V_{rms} I_{rms}}$$

* Power triangle

Real Power $= P = I^2 R$ Reactive Power $= I^2 X_L$

Apparent Power

$S = I^2 Z$

Here $\boxed{S = \sqrt{P^2 + Q^2}}$ $\Rightarrow$ $Z = \sqrt{R^2 + X_L^2}$

* Power Factor

It may be defined as

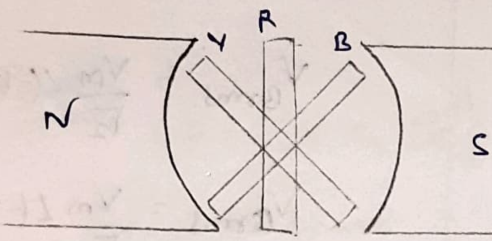
(i) Cosine of angle of lead or lag

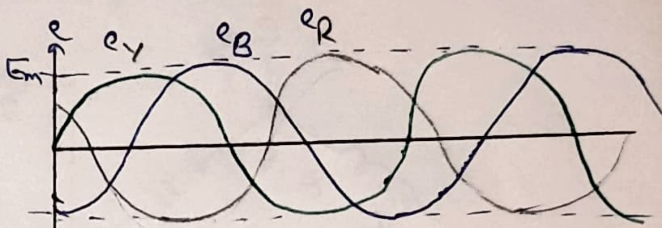
(ii) ratio of R/Z $= \dfrac{\text{True Power}}{\text{Apparent Power}} = \dfrac{P}{S}$

$$\boxed{\cos\phi = R/Z = P/S}$$

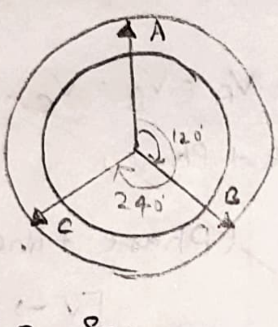
Three Phase AC Circuit :-

A three phase system consists of three seperate but identical windings that are displaced by 120° electrical degrees from each other. When these three windings are rotated in an anticlockwise direction ~~direction~~ with constant angular velocity in a uniform magnatic field. The emf are induced in each winding which have the same magnitude and displaced 120° from one another.





$e_R = E_m \sin \omega t$



$e_B = E_m \sin(\omega t - 120°)$

$e_Y = E_m \sin(\omega t - 240°)$

★ **Phase Sequence** The sequence in which the voltage in there phase reach maximum positive value is called the phase sequence or phase order.

Ex RYB => YBR => BRY

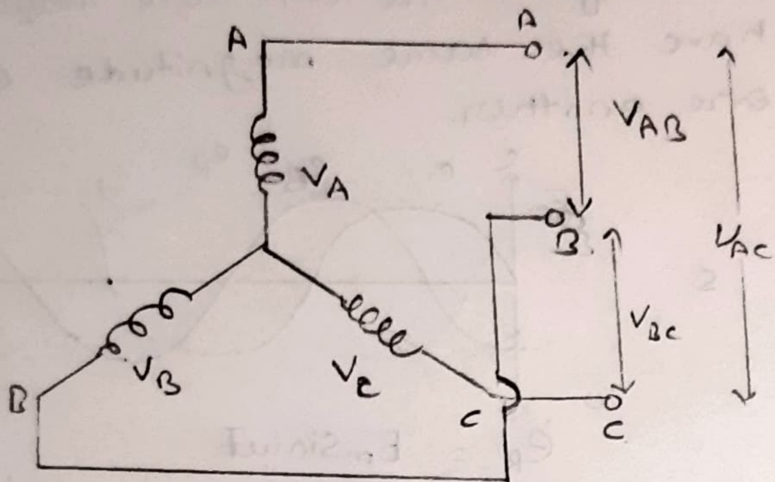
★ **Phase Voltage** :- The voltage induced in each winding is called the phase voltage.

★ **Phase current** :- The current flowing through each winding is called the phase current.

* **Line Voltage :-** The voltage available between any pair of terminal or linear is called the line voltage.

* **Line current :-** The current flowing through each line is called the line current.

- **Voltage Current Relation in Star Connection :-**



$V_{A\,rms} = V_m/\sqrt{2}$

$V_{B\,rms} = \frac{V_m}{\sqrt{2}} \angle(-120^\circ)$

$V_{C\,rms} = \frac{V_m}{\sqrt{2}} \angle(-240^\circ)$

Phase Voltage are $V_A = V_B = V_C$
(Phase + Phase)

V_{AB} , V_{BC} , V_{CA} => Line Voltage (Phase + line)
$(V_A - V_B)$ $(V_B - V_C)$ $(V_C - V_A)$

$[V \rightarrow (+)]$

$$V_{AB} = V_A - V_B$$

$$(V_{AB})^2 = (V_A - V_B)^2 = V_A^2 + V_B^2 + 2V_AV_B \cos\phi$$

Let $V_{AB} = V_{BC} = V_{CA} = V_L$

$V_A = V_B = V_C = V_P$

$$V_L^2 = V_P^2 + V_P^2 + 2V_P^2 \cos\phi$$

$$\phi = 60^\circ$$

$$V_L^2 = 2V_P^2 (1 + \cos 60^\circ)$$

$$V_L = \sqrt{2V_P^2 \times \frac{3}{2}}$$

$$\boxed{V_L = \sqrt{3}\, V_P}$$

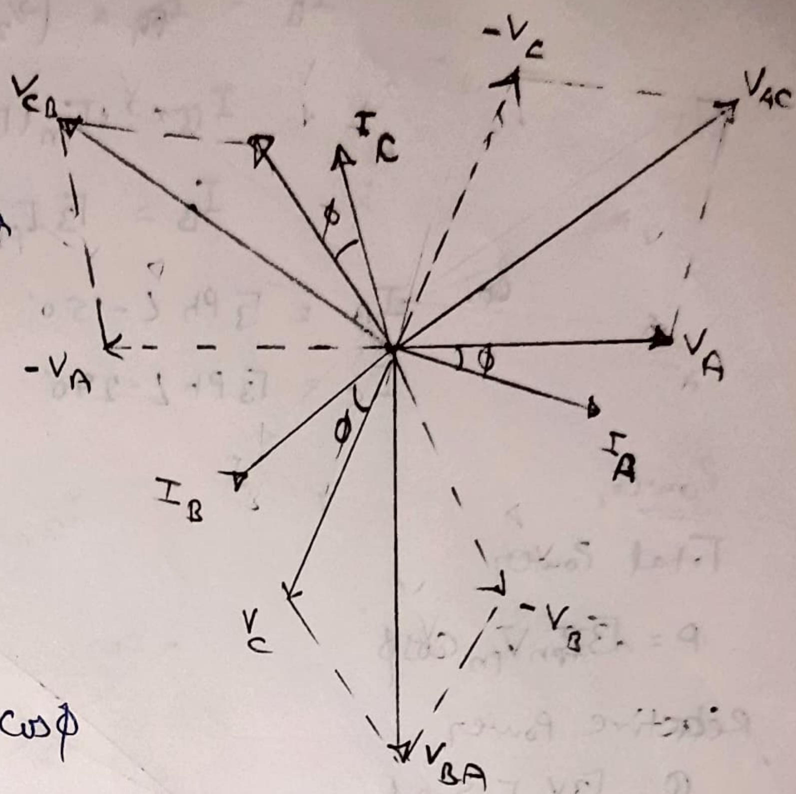
Phase current

$I_{AB} = I_{BC} = I_{CA} = I_{Ph}$

Line current

$I_A = I_B = I_C = I_L$

$$\boxed{I_L = I_{Ph}}$$



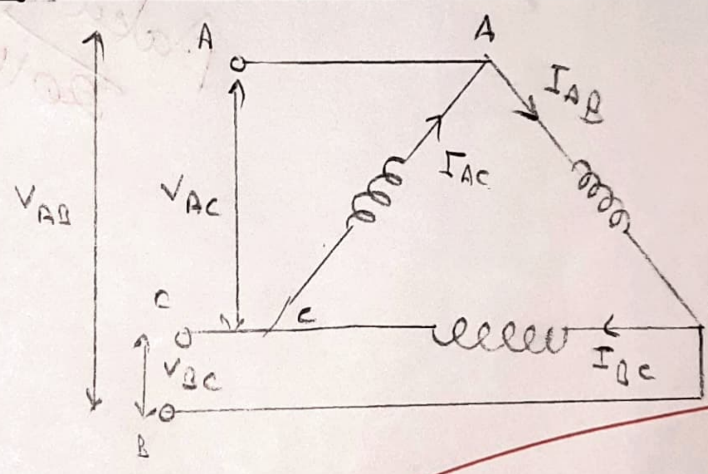
Power

$P = \sqrt{3} V_L I_L \cos\phi$

Reactive power => $Q = \sqrt{3} V_L I_L \sin\phi$

Apparent power => $S = \sqrt{3} V_L I_L$

• Voltage Current Relation ~~between~~ in Delta Connection.



$I_{AB} = I_{BC} = I_{CA} = I_{Ph}$ (Phase current Rms value)

$I_{AB} = I_{Ph}$

$I_{BC} = I_{Ph} \angle -120°$

$I_{CA} = I_{Ph} \angle -240°$

line Current (KCL)

$I_B = I_{AB} - I_{BC}$

$I_B = I_{Ph} - I_{Ph} \angle 120°$

$I_B = I_{Ph} - I_{Ph}(\cos 120° + j \sin 120°)$

$I_B = I_{Ph}\left(1 - \left(-\tfrac{1}{2}\right) + j \tfrac{\sqrt{3}}{2}\right)$

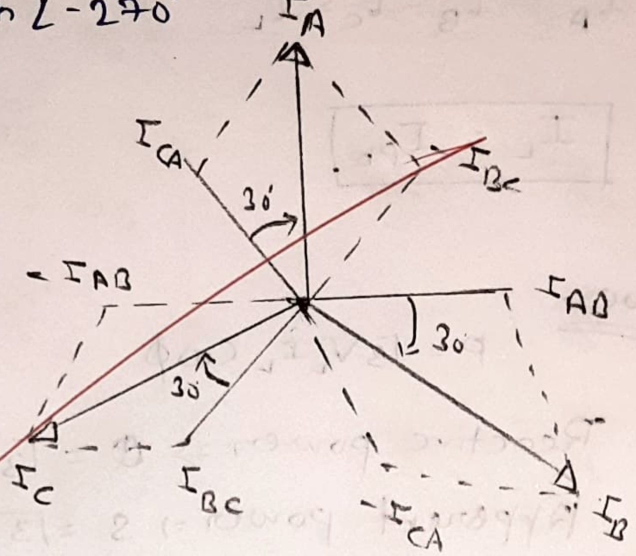
$I_B = \cancel{I_{ph}} = \left(\frac{3}{2} - j\frac{\sqrt{3}}{2}\right) I_{ph}$

$I_B = I_{ph}(\sqrt{3})\left(\frac{\sqrt{3}}{2} - \frac{1}{2}j\right)$ $\cos 30^\circ = \frac{\sqrt{3}}{2}$

$I_B = \sqrt{3}\, I_{ph} \angle -30^\circ$

& $I_A = \sqrt{3}\, Ph \angle -150^\circ$

$I_C = \sqrt{3}\, Ph \angle -270^\circ$



Power

Total Power

$P = \sqrt{3} I_{ph} V_{ph} \cos\phi$

~~Rebctive~~ Reactive Power

$Q = \sqrt{3} V_L I_L \sin\phi$

apperent power

$S = \sqrt{3} V_L I_L$

Aakanksha
20/11/24