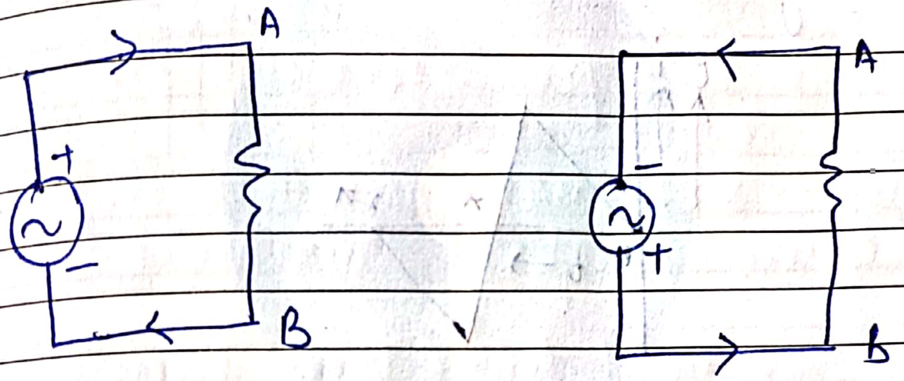
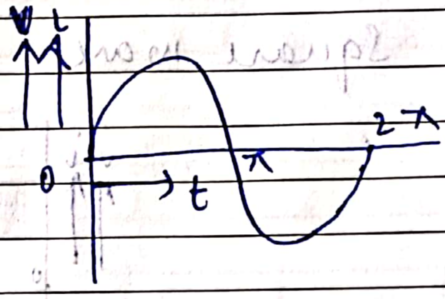
Chapter 2
AC circuits

Alternating voltage & current :-

A voltage that changes its polarity & magnitude at regular intervals of time is called alternating voltage.

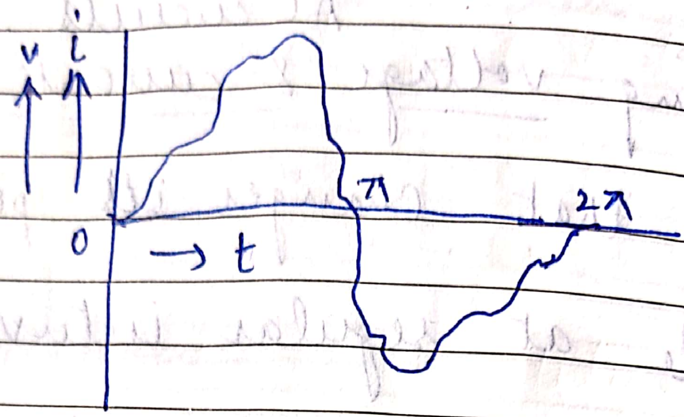


wave shape of the source voltage or waveform.

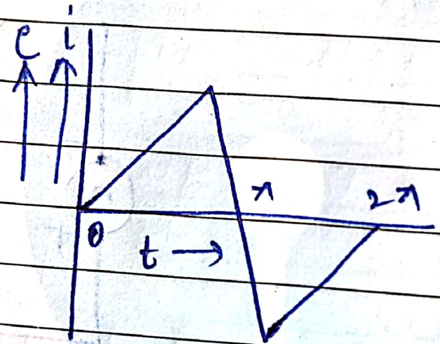


Important Notes The alternating voltage or current vary in different manner. accordingly their wave shapes are named in different ways such as :-

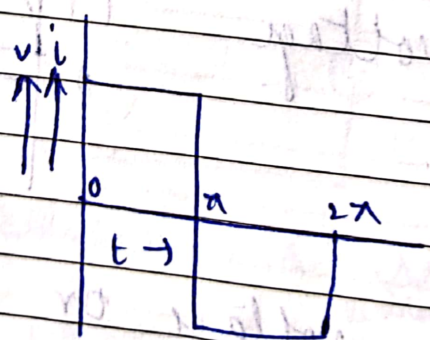
1) Irregular wave



(2) Triangular wave



(3) Square wave

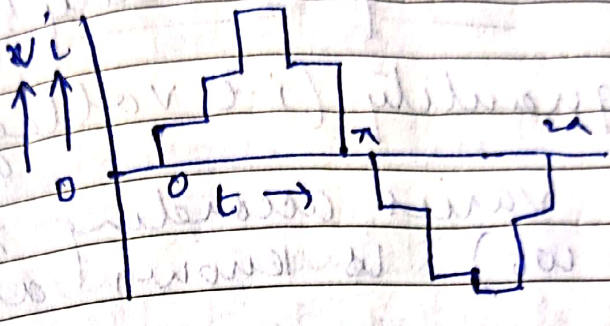


Important Notes

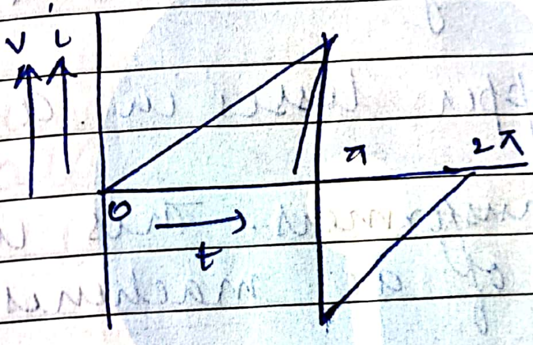
(4) Periodic wave

JUNE 2014

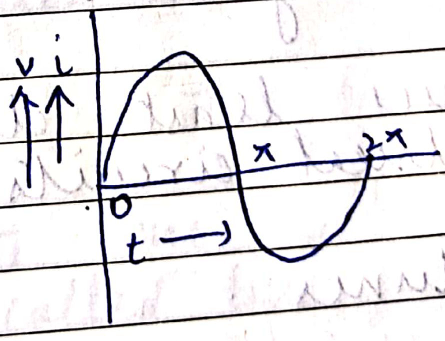
M	T	W	T	F	S	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						



(5) saw-tooth wave



(6) sine wave



Important Notes

Sinusoidal Alternating Quantity :-

An alternating quantity (i.e voltage or current) which varies according to sine of angle θ (θ = ωt) is known as sinusoidal alternating quantity.

(1) Sinusoidal voltages & currents produce low iron & copper losses in a.c rotating machines & transformers. This improves the efficiency of ac machines.

(2) The sinusoidal voltages & current offer less interferance to nearby communication system.

(3) They produce least disturbance in the electrical circuits.

Important terms.

Important Notes

SUNDAY

(1) Waveform :- The shape of curve obtained by plotting the instantaneous values of alternating quantity along y-axis

and time or angle ($\theta = \omega t$) along x-axis is called waveform

(2) Instantaneous value :- The value of an alternating quantity i.e voltage or current at any instant is called its instantaneous value & is represented by v or i. resp.

(3) Cycle :- when an alternating quantity goes through a complete set of +ve & -ve values or goes through 360 electrical degrees it is said to have one complete cycle.

(4) Alternation :- One half cycle is called alternation. An alternation spans 180 electrical degrees.

(5) Time period :- The time taken in seconds to ~~cof~~ complete one cycle by an alternating quantity is called time period. It is

Important Notes

generally denoted by T.

(6) Frequency :- The number of cycles made per second by an alternating quantity is called frequency. It is measured in

cycles per second or hertz (Hz) & is denoted by f.

(7) Amplitude:- The maximum value (+ve or -ve) attained by an alternating quantity in one cycle is called its amplitude or peak value or max value. The max value of voltage or current is generally denoted by E_m or V_m & I_m resp.

(1) Relation b/w Time & frequency

Time taken to complete f cycle = 1 sec

" " " " 1 cycle = $\frac{1}{f}$ sec.

$$\boxed{T = \frac{1}{f} \text{ sec}} \quad \text{or} \quad \boxed{f = \frac{1}{T}} \text{ c/s.}$$

Important Notes

) Relation b/w frequency & angular velocity.

Angular distance covered in one cycle = 2π radians

Angular distance covered per seconds in f cycle = $2\pi f$ radian

$$\boxed{\omega = 2\pi f \text{ radians/sec}}$$

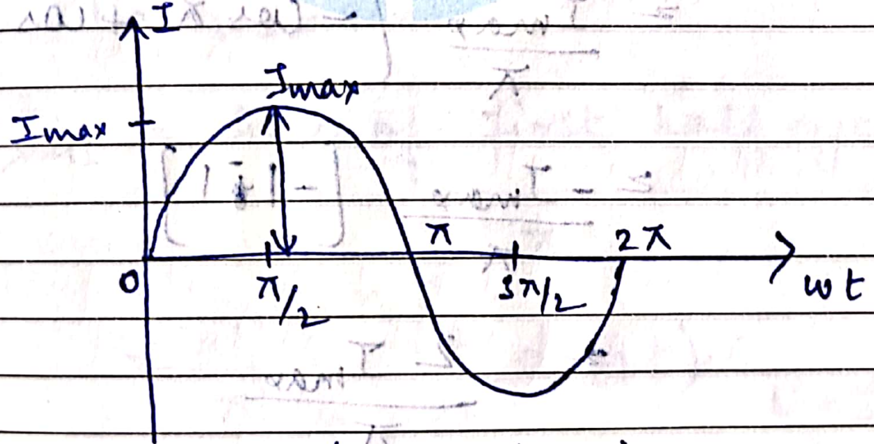
Instantaneous value of sinusoidal current is .

$$i = I_{max} \sin \omega t$$

Instantaneous value of sinusoidal voltage

$$v = V_{max} \sin \omega t$$

Average value for sinusoidal voltage & current.



Important Notes

The average value of sine wave over a complete cycle is zero, therefore the half cycle average value is considered.

Graphical Method

Generalised I_{av} formula of I_{av} is: $I_{av} = \dfrac{\text{Area of alternation}}{\text{base}} = \dfrac{i_1+i_2+\dots}{n}$

$i = I_{max} \sin \omega t$.

$$I_{av} = \frac{\text{Area of first half cycle}}{\pi}$$

Analytical Method

$$= \frac{1}{\pi}\int_0^{\pi} i \, d\omega t$$

$$= \frac{1}{\pi}\int_0^{\pi} I_{max} \sin(\omega t)\, d(\omega t)$$

$$= \frac{I_{max}}{\pi}\Big[-\cos \omega t\Big]_0^{\pi}$$

$$= \frac{I_{max}}{\pi}\left(-\cos \pi + \cos 0\right)$$

$$= \frac{-I_{max}}{\pi}\left[-1 \mp 1\right]$$

$$= \frac{2 I_{max}}{\pi}$$

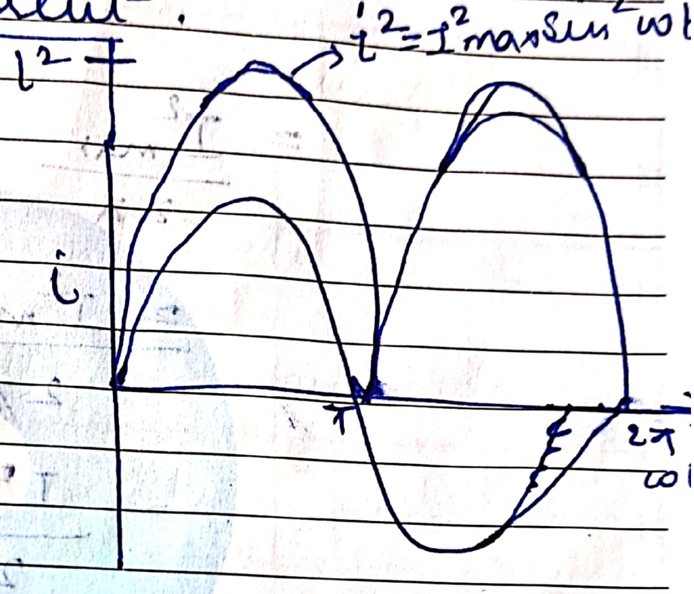
Important Notes

$$= \frac{2}{\pi} I_{max}$$

$I_{av} = 0.637 \, I_m$ (+ve half cycle)

III. $\boxed{V_{av} = 0.637\, V_{max}}$

Effective (rms) value for sinusoidal voltage or current.



Instantaneous value

$$i = I_{max}\sin\omega t$$

$$I^2_{rms} = \frac{\text{Area of first half cycle of } i^2}{\pi}$$

$$= \frac{1}{\pi}\int_0^{\pi} i^2 \, d(\omega t) \qquad i^2 = I^2_{max}\sin^2\omega t$$

$$= \frac{I_{max}^2}{\pi}\int_0^{\pi} \sin^2\omega t \, d(\omega t)$$

$$\sin^2\omega t = \frac{1-\cos 2\omega t}{2}$$

$$= \frac{I^2_{max}}{2\pi} \int_0^{\pi} (1 - \cos 2\omega t) \cdot d\omega t$$

$$= \frac{I^2_{max}}{2\pi} \left[\omega t - \frac{\sin 2\omega t}{2} \right]_0^{\pi}$$

$$= \frac{I^2_{max}}{2\pi} (\pi - 0)$$

$$= \frac{I^2_{max} \times \cancel{\pi}}{2 \cancel{\pi}}$$

$$= \frac{I^2_{max}}{2}$$

$$\cancel{I_{rms}} = \cancel{\sqrt{I}}$$

$$I_{rms}^2 = \frac{I^2_{max}}{2}$$

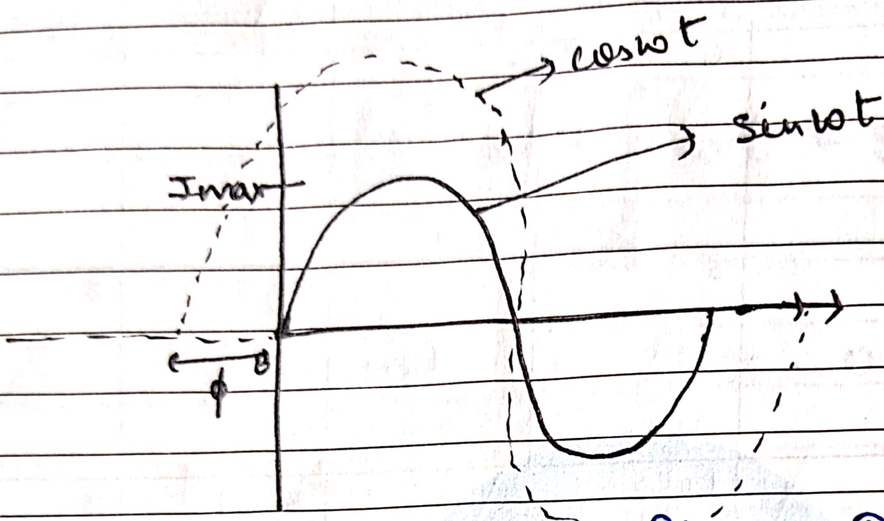
$$I_{rms} = \sqrt{\frac{1}{2}}\, I_{max}$$

Important Notes

$$I_{rms} = \frac{1}{\sqrt{2}} I_{max}$$

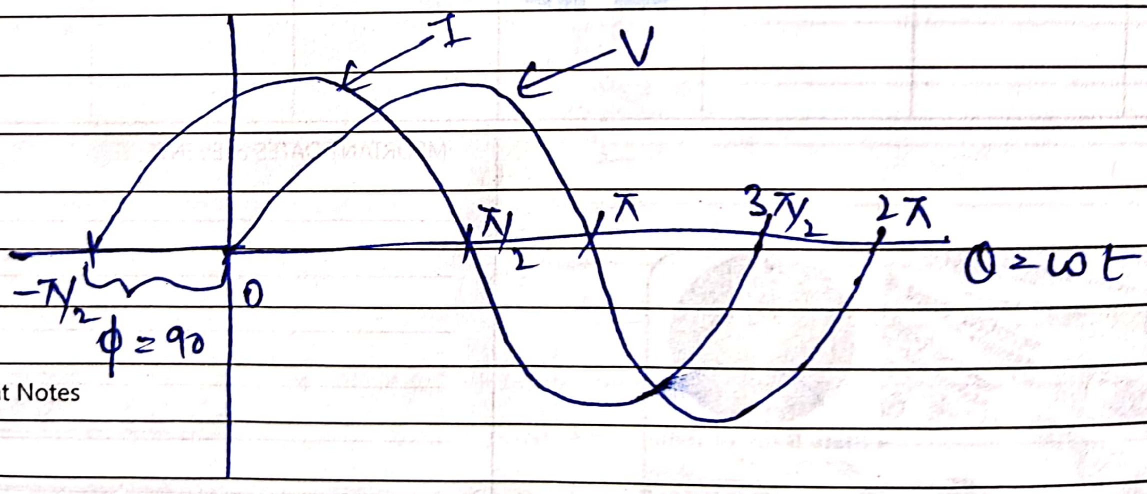
$$= 0.707\, I_{max}$$

Phase Angle or Phase Difference



Phase or Phase Difference

It is the angular shift or time delay between two waves of the same frequency, indicating how much one wave leads or lags the other. It is measured in degrees or radians.



Important Notes

Numericals

Form factor:-

The ratio of rms value to average value of an alternating quantity is called form factor.

$$\text{Form factor} = \frac{I_{rms}}{I_{av}}$$

For the current varying sinusoidally.

$$\text{Form factor} = \frac{I_{rms}}{I_{av}} = \frac{I_m/\sqrt{2}}{2I_m/\pi} = \frac{\pi I_m}{2\sqrt{2}I_m}$$

$$= 1.11$$

Peak factor:- The ratio of maximum value to rms value of an alternating quantity is called peak factor.

$$\text{Peak factor} = \frac{I_m}{I_{rms}}$$

For current varying sinusoidally

$$\text{Peak factor} = \frac{I_m}{I_{rms}} = \frac{I_m}{I_m/\sqrt{2}} = \sqrt{2} = 1.414$$

Q An alternating current is given by the expression $i = 50 \sin 628t$.

Determine (i) max value of current

(ii) rms value of current

(iii) frequency of current

(iv) value of current after $t = 0.00625$ s

(v) time taken by the current to reach a value of 20A.

(i) $I_m = 50$ A

(ii) $I_{rms} = I_m/\sqrt{2} = 50/\sqrt{2} = 35.355$A.

(iii) $\omega = 2\pi f = 628$ or $f = \dfrac{628}{2\pi} = 100$ Hz

(iv) $i = 50 \sin 628 \times 0.00625 = -35.3$A

(v) $20 = 50 \sin 628t$

Important Notes

$$\sin 628t = \frac{20}{50} = 0.8$$

$$628t = \sin^{-1} 0.8 = 0.9273$$

$$t = \frac{0.9273}{628} = 1.4766 \times 10^{-3} \text{ s}$$

Q An alternating current of 50 Hz has a max value of 200 A. Reckoning time from the instant current is zero & is becoming +ve, calculate

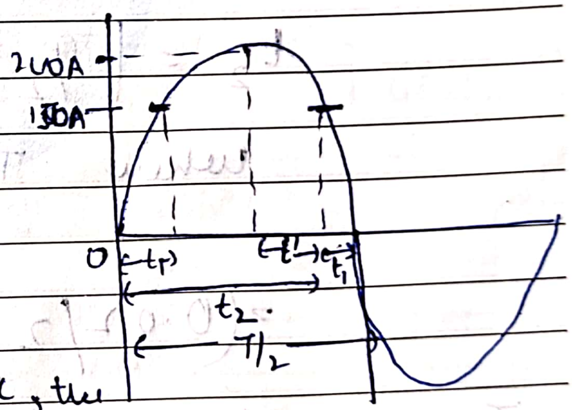
(i) the instantaneous value after 1/400 s.

(ii) the time taken for the current to reach 150 A for the first & second time.

If the reckoning time is taken from the instant current is max +ve & becoming zero, after what time it will reach to 150 A.

Sol:- $i = I_m \sin 2\pi f t$.

$i = 200 \sin 100\pi t$



Taking reckoning time from the instant current is zero & becoming positive, the eqn

(i) $i = 200 \sin 100\pi t$

Important Notes

$= 200 \sin \frac{100}{400}\pi = 200 \sin \pi/4 = 200 \sin 45°$

$= 141.42\text{ A}$

(ii) Let the current reaches to 150A for the first time after t_1 sec.

$$200 \sin 100\pi t_1 = 150$$

$$\sin 100\pi t_1 = 0.75$$

$$100\pi t_1 = \sin^{-1} 0.75$$

$$t_1 = 0.84806 / 100\pi = 2.7\text{ms}$$

Let the current reaches to 150A for the second time after t_2 sec.

$$t_2 = (T/2 - t_1)$$

when $T = \frac{1}{f} = \frac{1}{50} = 0.02\text{s}$

$$= (0.02/2) - 2.7 \times 10^{-3} = 7.3\text{ ms}$$

If the reckoning time is taken from the instant current is max +ve, the current

$$i = I_m \sin(\omega t + 90^\circ) = I_m \cos \omega t$$

$$= 200 \cos 100\pi t$$

Important Notes

Let the current reaches 150A after t' sec.

$150 = 200 \cos \pi t'$ or $\cos 100\pi t' = 0.75$.

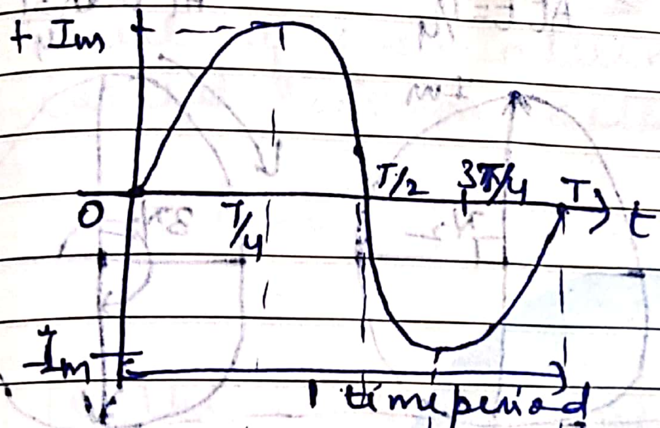
$100\pi t' = \cos^{-1} 0.75$

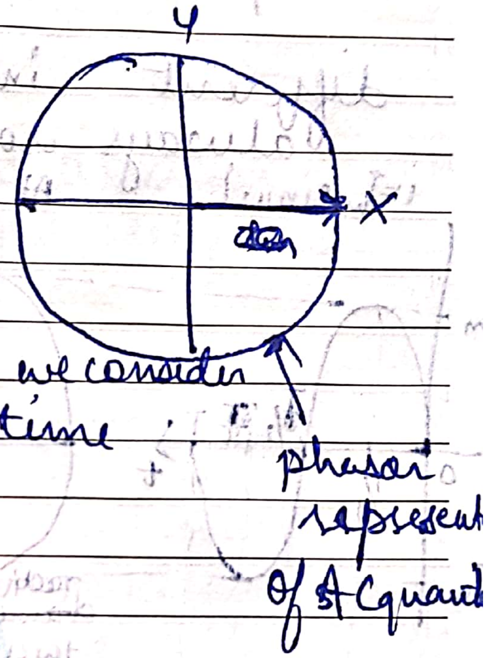
$100\pi t' = 0.7227$ radians.

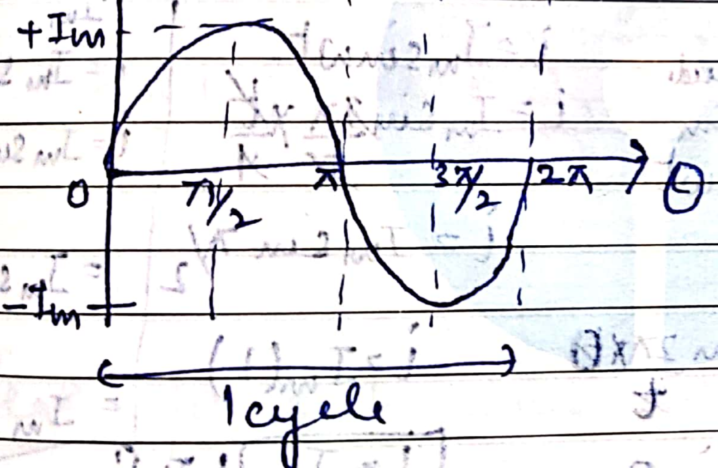
$t' = \dfrac{0.7227}{100\pi} = 2.3\,ms.$

Phasor Representation of sinusoidal quantity

$i = I_m \sin \omega t$







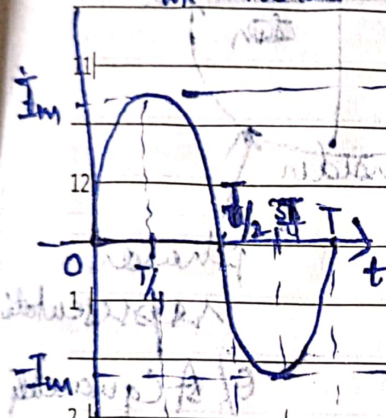
now considering angle θ

phasor representation means the circular representation

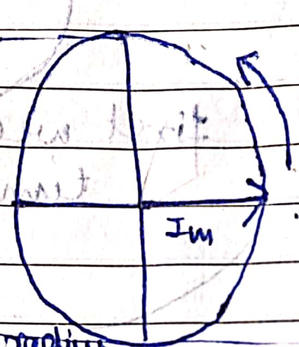
why we use phasor representation - to understand the direction of current.

To find the direction of current on different intervals of time & vector I_m always rotate in anti-clockwise direction.

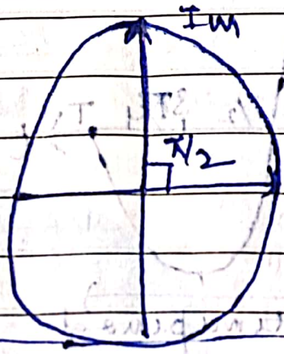
$i = I_m \sin \omega t$



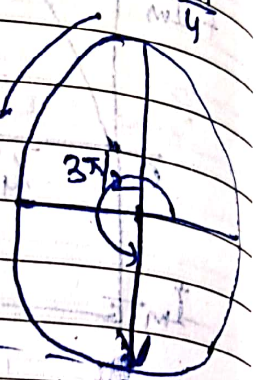
At $t = 0$



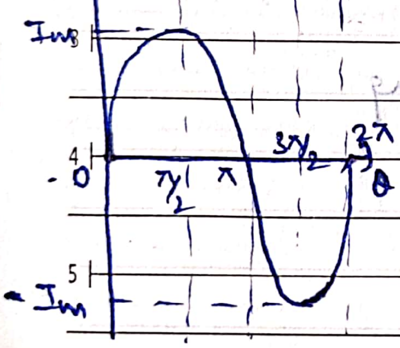
At $t = T/4$



At $t = 3T/4$



~~diameter~~ radius of the circle is equal to magnitude of current i.e I_m



$i = I_m \sin \omega t$

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

$i = I_m \sin \frac{2\pi \times 0}{t}$

$i = I_m \sin 0$

$\boxed{i = 0}$ $t = 0$

$i = I_m \sin \omega t$

$i = I_m \sin \frac{2\pi}{t} \times \frac{t}{4}$

$i = I_m \sin \pi/2$

$i = I_m(1)$

$\boxed{i = I_m}$ $t = T/4$

$i = I_m \sin \omega t$

$i = I_m \sin \frac{2\pi}{t} \times \frac{3t}{4}$

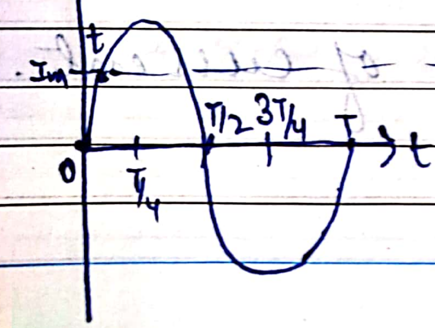
$= I_m \sin \frac{3\pi}{2}$

$= I_m(-1)$

$\boxed{i = -I_m}$

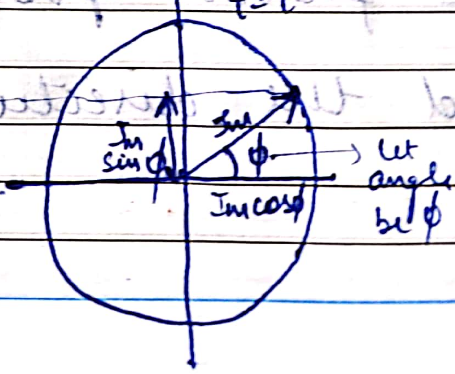
Let at any time $= t$

Important Notes



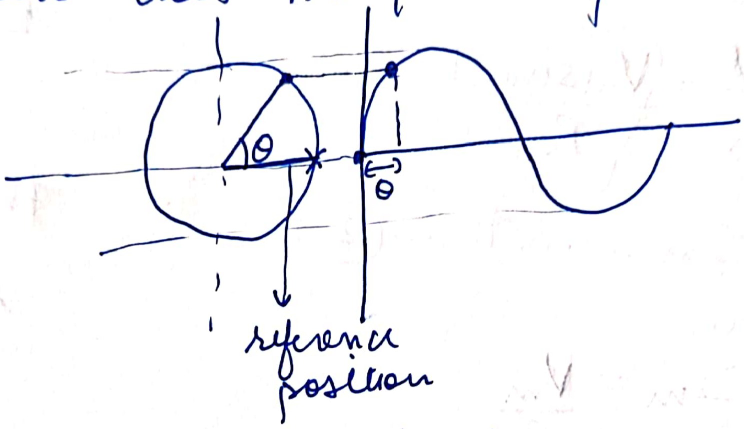
At time $= t$

$t = t$



Concept of Phasor

It gives information about any AC quantity that how much it is from reference position we can represent this AC quantity in vector form



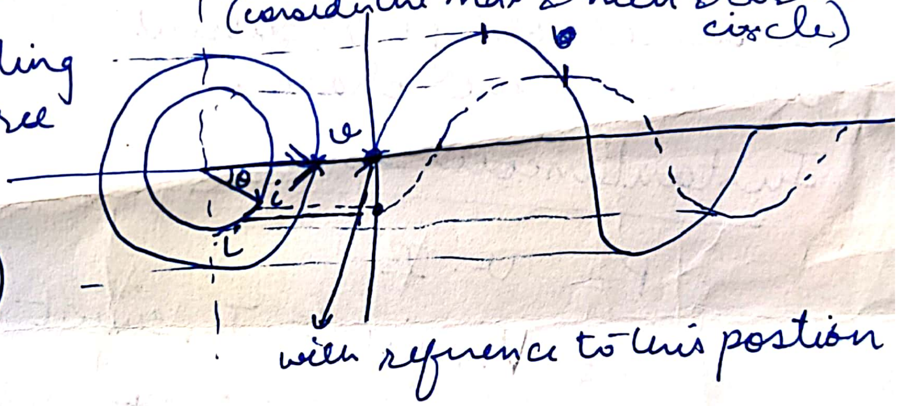
3 cases can be considered, if two quantities are considered :- (one is current & other is voltage)

Case I

voltage is leading by θ degree

$v = v_m \sin \omega t$

$i = I_m \sin(\omega t - \theta)$

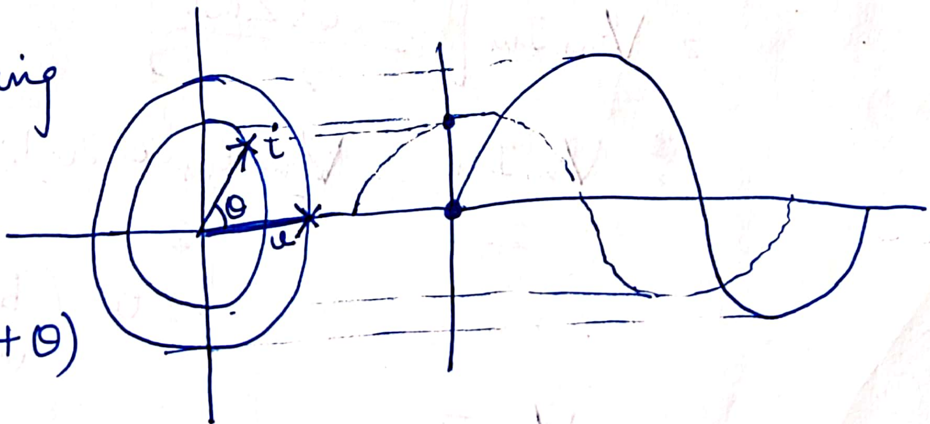


Case II :-

current is leading by θ degree

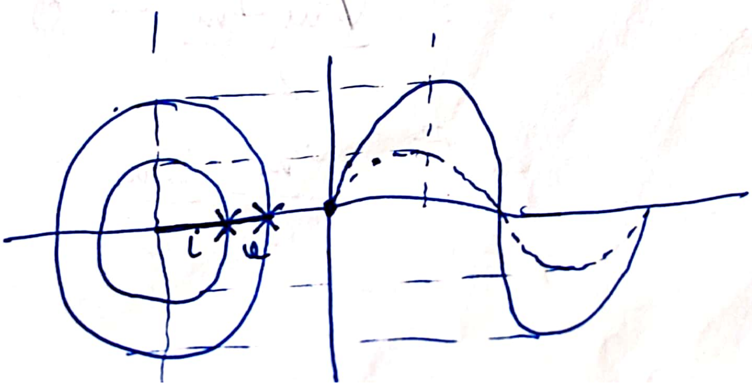
$v = v_m \sin \omega t$

$i = I_m \sin(\omega t + \theta)$



Case III :-

Both v & i are in same direction.

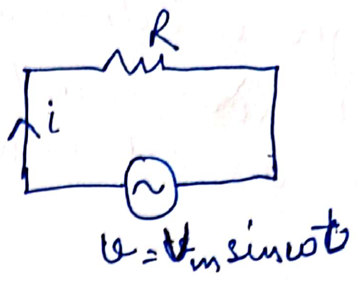


Scanned with OKEN Scanner

AC through Pure Resistive Circuit

In given circuit

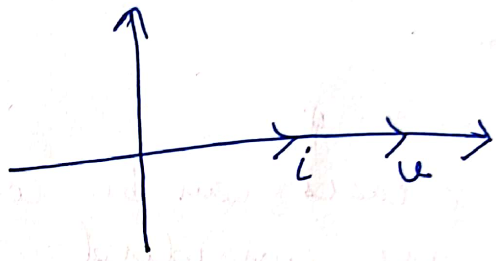
$v = V_m \sin \omega t$ — (1)



$i = \frac{v}{R} = \frac{V_m \sin\omega t}{R}$

$= I_m \sin \omega t$ — (2)

Phasor



where

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

Here phase difference is 0 because voltage & current are in same phase.

Instantaneous power

$P = v \cdot I$

$= V_m \sin\omega t \cdot I_m \sin\omega t$

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

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

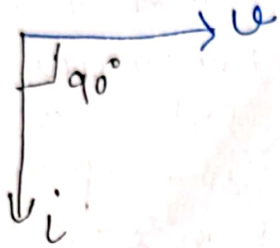
$= \frac{V_m I_m}{2} - \frac{V_m I_m \cos 2\omega t}{2}$

$\hookrightarrow 0$ (because Average value of complete cycle is zero)

$= \frac{V_m I_m}{2} - 0$

$= \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}} = V_{rms} \cdot I_{rms}$

Phasor :-



current is lagging behind the voltage by 90°.

Power :-

$P = V \cdot I$

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

Multiply & divide by 2

$= \frac{V_m I_m}{2} \cdot 2 \sin \omega t \cos \omega t$ $\quad (2 \sin A \cos A = \sin 2A)$

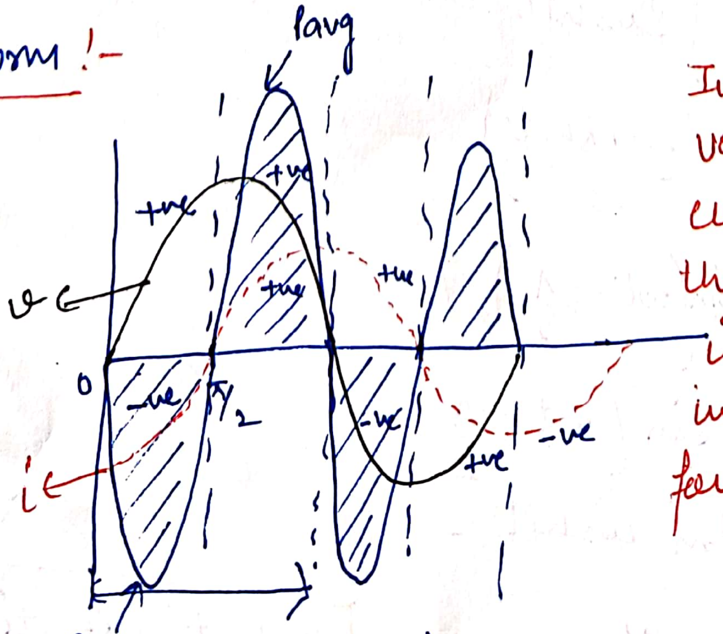
$P = \frac{V_m I_m}{2} \cdot \underbrace{\sin 2\omega t}_{\to 0}$

Average Power :-

$P_{avg} = \frac{V_m I_m}{2} \cdot 0$

$\boxed{P_{avg} = 0}$ because again Average Power of complete cycle is 0.

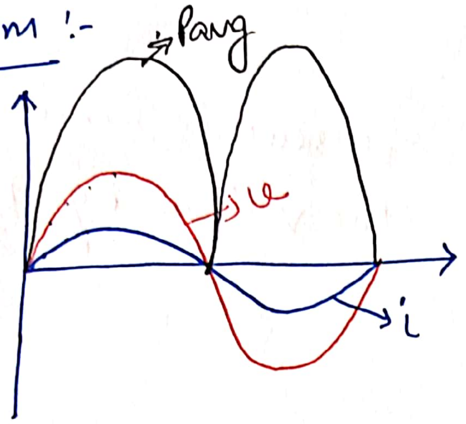
Waveform :-



In the first half voltage is +ve & current is -ve, so the first half cycle is further divided into two half cycles for Power calculation

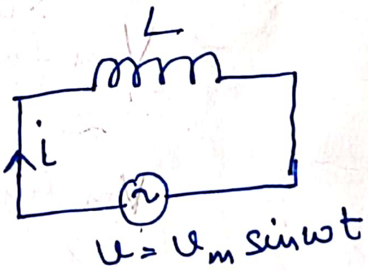
$P_{avg} = 0$ (for 1cycle)

waveform :-



In the first halfcycle all +ve values of voltage multiply with +ve values of current so waveform is +ve for Pavg & in second half cycle -ve value of voltage multiply with -ve value of current, so -ve & -ve becomes +ve, so Pavg is +ve in the next half cycle as well.

AC through Pure Inductive Circuit :-



Given :-

$$v = V_m \sin\omega t \quad \text{—— (1)}$$

Emf in inductor

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

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

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

Integrating both sides

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

$$i = \frac{V_m}{L}\left(\frac{-\cos\omega t}{\omega}\right)$$

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

$$i = I_m \sin\left(\omega t - \frac{\pi}{2}\right) \quad \text{—— (2)}$$

$$i = -I_m \cos\omega t \quad \text{—— (3)}$$

where

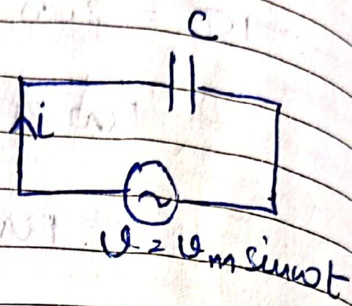
$$I_m = \frac{V_m}{\omega L}$$

$$\boxed{\frac{V_m}{I_m} = \omega L = X_L}$$

Inductive Reactance is the resistance offered by the inductor. It is known as inductive Reactance.

AC through Pure ~~Conductance~~ Capacitive Circuit

$$v = v_m \sin\omega t \quad \text{—— (1)}$$



Charge

$$q = Cv$$
$$= C v_m \sin\omega t$$

and

$$i = \frac{dq}{dt} = \frac{d}{dt}\left[C v_m \sin\omega t\right]$$

$$i = \underbrace{C v_m \omega}\cos\omega t$$

$$i = I_m \cos\omega t \quad \text{—— (2)}$$

$$\boxed{i = I_m \sin\left(\omega t + \frac{\pi}{2}\right)} \quad \text{—— (3)}$$

where

$$I_m = C v_m \omega$$

$$\boxed{\frac{v_m}{I_m} = \frac{1}{\omega C} = X_C}$$

This is the resistance offered by the capacitor known as Capacitive Reactance.

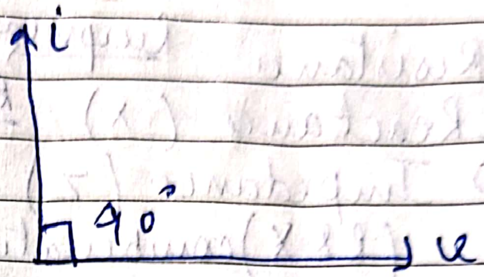
Important Notes

Instantaneous Power

$$P = v \cdot I = v_m \sin\omega t \; I_m \cos\omega t$$

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

Phasor



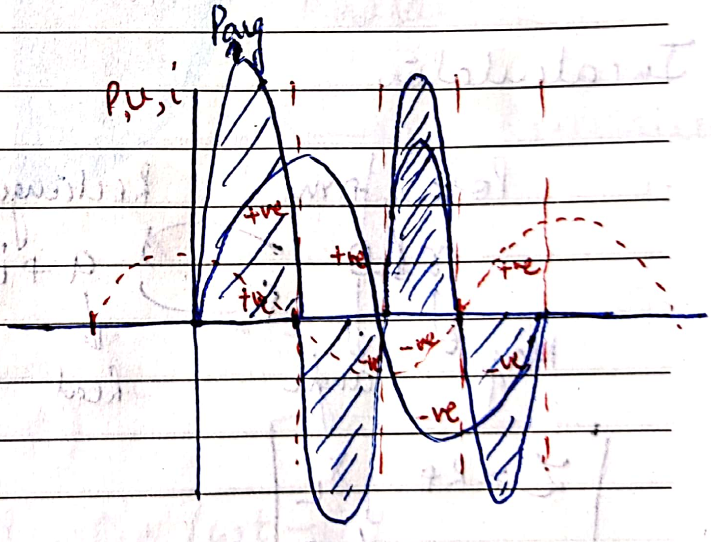
(current is leading by 90° from voltage)

Average Power.

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

$$= \frac{V_m I_m}{2} \cdot 0$$

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



Important Notes

Numericals :-

Q An a.c circuit consists of pure resistance of 10Ω & is connected across an ac supply of 230V, 50Hz

Calculate

(1) Current
(2) Power consumed
(3) Write down the eq. for voltage & current.

(1) $I = \frac{V}{R} = \frac{230}{10} = 23A$

(2) $P = VI = 230 \times 23 = 5290W$

(3) $V_m = \sqrt{2}V$, $I_m = \sqrt{2}I$

$= \sqrt{2} \times 230$, $I_m = \sqrt{2} \times 23$

$V_m = 325.27V$, $I_m = 32.53A$

$\omega = 2\pi f = 2\pi \times 50 = 314.16$ rad/s

Important Notes

$v = V_m \sin \omega t$

$= 325.27 \sin 314.16t$

$i = I_m \sin \omega t$

$= 32.53 \sin 314.16t$

Q An inductive coil having negligible resistance & 0.1 henry Inductance is connected across 240V, 50 Hz supply. find:

(1) Inductive reactance

(2) Rms value of current.

(3) Power.

(4) eqⁿ for voltage & current.

Sol! -

(1) $X_L = \omega L$

$= 2\pi f L = 2\pi \times 50 \times 0.1$

$= 31.416 \Omega$

(2) $I = \frac{V}{X_L} = \frac{200}{31.416} = 6.366$ A

(3) $P = 0$

(4) $V_m = \sqrt{2} V$, $I_m = \sqrt{2} I$

Important Notes

$V_m = \sqrt{2} \times 200$, $I_m = \sqrt{2} \times 6.366$

$= 282.84$ V. $I_m = \cancel{282.8}$ 9 A

$\omega = 2\pi f = 2\pi \times 50 = 314$ rad/s

$v = V_m \sin \omega t$

$= 282.84 \sin 314t$

$i = I_m \sin(\omega t - \frac{\pi}{2})$

$= 9 \sin(314t - \pi/2)$

Q3. ~~A two~~ A capacitor has a capacitance of 30 micro farad. find its capacitive reactance for freq of 25 & 50Hz. find in each case the current if the supply voltage is 440V.

Sol:- Capacitance $= 30 \times 10^{-6}$ F.

Supply voltage $= 440$ V

When supply frequency $f_1 = 25$ Hz

$$X_{C_1} = \frac{1}{\omega_1 C} = \frac{1}{2\pi \times 25 \times 30 \times 10^{-6}}$$

$= 212.2 \Omega$

rtant Notes

$$I_1 = \frac{V}{X_{C_1}} = \frac{440}{212.2} = 2.073\ A$$

when supply freq $f_2 = 50\ Hz$

$$X_{C_2} = \frac{1}{\omega_2 C} = \frac{1}{2\pi \times 50 \times 30 \times 10^{-6}}$$

$$= 106.1\ \Omega$$

$$I_2 = \frac{V}{X_{C_2}} = \frac{440}{106.1} = 4.146\ A$$

Concept of Impedance.

Resistance $\xrightarrow{\text{Reciprocal}}$ Conductance

Reactance (X) $\xrightarrow{\text{Reciprocal}}$ Susceptance

Impedance (Z) $\xrightarrow{\text{Reciprocal}}$ Admittance

(R & X) combination is known as Impedance

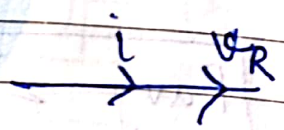
Impedance

$$Z = R + jX_L \Rightarrow \sqrt{R^2 + X_L^2} = |Z| \text{ Magnitude}$$

$$\text{Angle. } \angle Z = \tan^{-1}\left(\frac{X_L}{R}\right)$$

$$Z = R - jX_C$$

In calculation

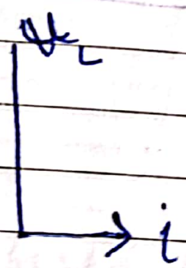


Resistance

Polar form $\leftrightarrow$ Rectangular form.

$r \angle \theta$ $\qquad$ $a + ib$

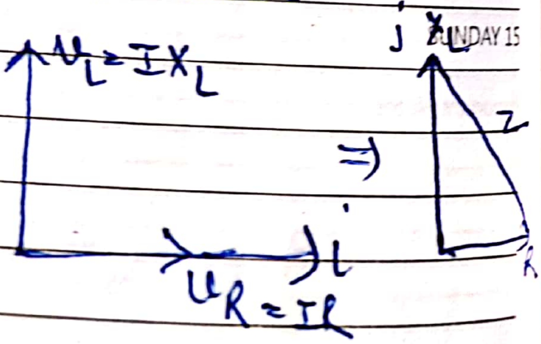
Mag $\quad$ angle $\qquad$ Real $\quad$ Imag.



Inductor X_L

$$\boxed{\begin{aligned} Z &= R + jX_L \\ &= Z \angle \theta \end{aligned}}$$

combine both.



Important Notes

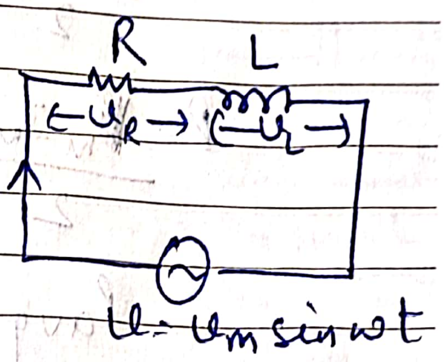
AC through Series R-L circuit

$v = V_m \sin \omega t$ — (1)

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

$I\vec{Z} = \vec{IR} + \vec{IX_L}$

$\vec{Z} = \vec{R} + \vec{X_L}$



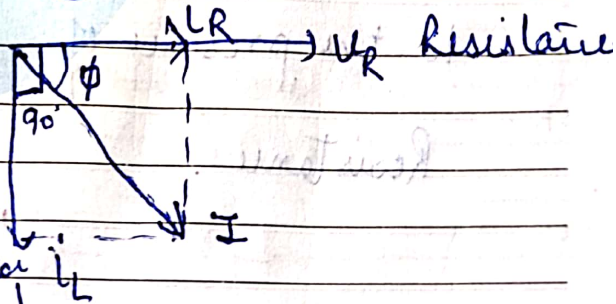
Magnitude $|Z| = \sqrt{R^2 + X_L^2}$

Angle $\angle\theta = \tan^{-1}\left(\frac{X_L}{R}\right)$ } Impedance.

$v = V_m \sin \omega t$ — (1)

$i = I_m \sin(\omega t - \phi)$ — (2)

Phasor:



Power:

$P = V \cdot I$

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

$= \frac{V_m I_m}{2} 2 \sin \omega t \cdot \sin(\omega t - \phi)$

$[2 \sin A \sin B = \cos(A - B) - \cos(A+B)]$

$= \frac{V_m I_m}{2}\left[\cos(\cancel{\omega t} - \cancel{\omega t} + \phi) - \cos(\omega t + \omega t - \phi)\right]$

Important Notes

'14 Wk 25 DAYS 168-197

State Bank of India
THE BANKER TO EVERY INDIAN

17 JUNE TUESDAY

$$P = \frac{V_m I_m}{2}\left[\cos\phi - \cos(2\omega t - \phi)\right]$$

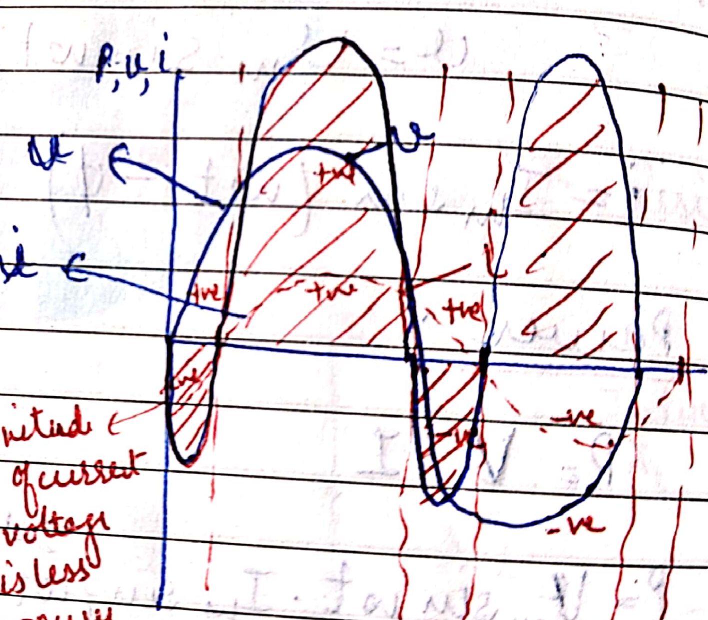
$$P = \frac{V_m I_m}{2}\cos\phi - \frac{V_m I_m}{2}\cos\underbrace{\left[2\omega t - \phi\right]}_{\to 0}$$

$$P_{avg} = \frac{V_m I_m}{2}\cos\phi$$

$$P_{avg} = V_{rms} I_{rms} \cos\phi$$

$$= V \cdot I \cos\phi$$

This power is due to the presence of Resistance.

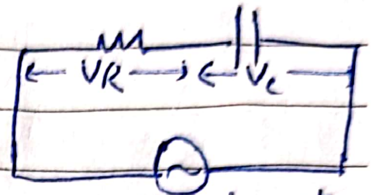


Magnitude of current & voltage is less so power waveform is less.

Important Notes

AC through series R-C circuit

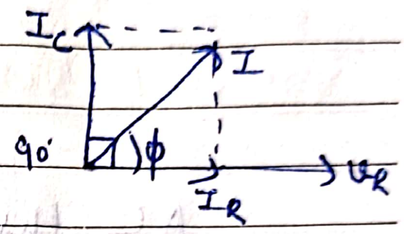
$$\vec{V} = \vec{V_R} + \vec{V_C}$$



$V = V_m \sin \omega t$

$$\vec{IZ} = \vec{IR} + \vec{IX_C}$$

$$|Z| = \sqrt{R^2 + X_C^2}$$



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

$$V = V_m \sin \omega t$$

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

Power

$$P = V \cdot I$$

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

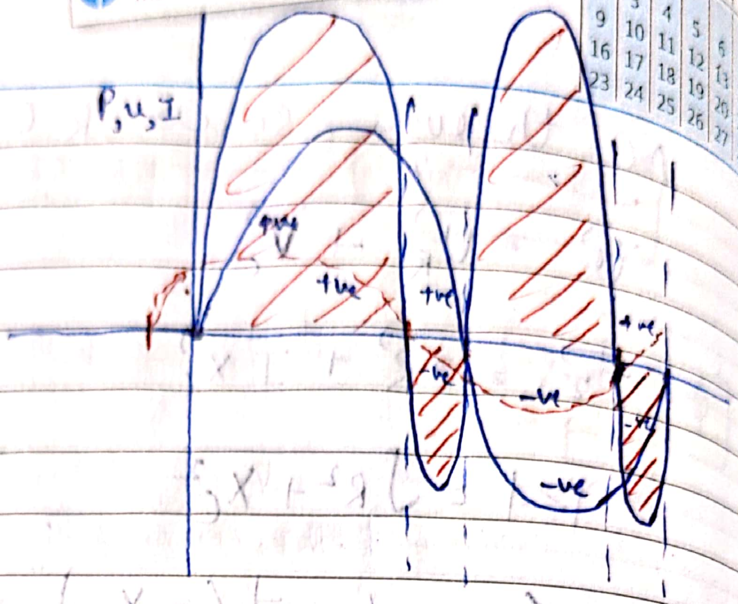
$$= \frac{V_m I_m}{2}\left[\cos\phi - \underbrace{\cos(2\omega t + \phi)}_{\to 0}\right]$$

Average Power

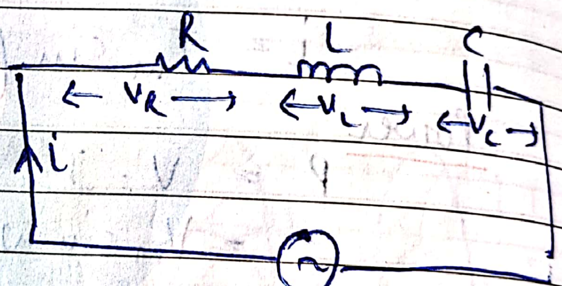
$$P_{avg} = \frac{V_m I_m}{2} \cos\phi$$

$$\boxed{P_{avg} = VI \cos\phi}$$

Important Notes



AC through series RLC circuit



$Z = R + jX_L - jX_C$

$= R + j(X_L - X_C)$

① when X_L is greater than X_C

$X_L > X_C$

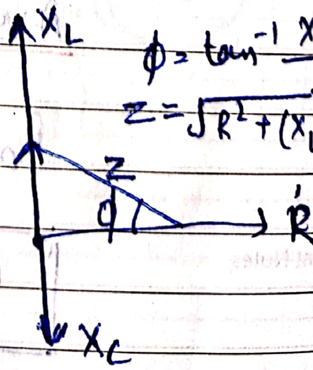
$Z = \sqrt{R^2 + (X_L - X_C)^2}$

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

Phasor

$\phi = \tan^{-1} \frac{X_L - X_C}{R}$

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



$(X_L - X_C)$ is in upward direction because X_L is greater as compared to X_C

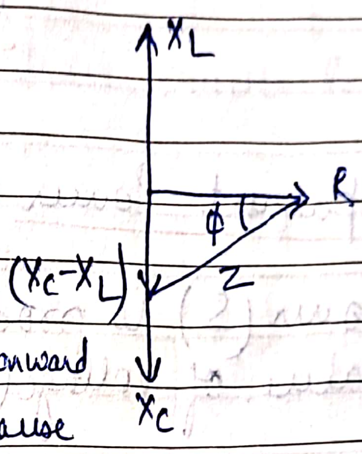
Important Notes

Circuit will be inductive

(2) when $X_L < X_C$

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

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



circuit will capacitive

downward because X_C is greater than X_L

(3) when $X_L = X_C$

$$X_L - X_C = 0$$

$$Z = R$$

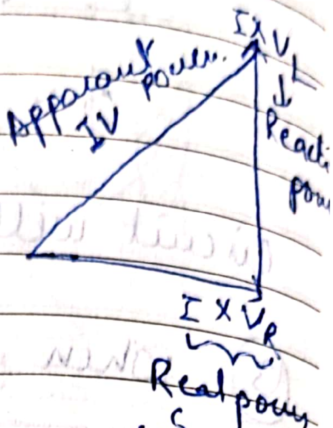
Circuit will be Resistance.

JUNE 2014

M	T	W	T	F	S	S
30						
2	3	4	5	6	7	1
9	10	11	12	13	14	8
16	17	18	19	20	21	15
23	24	25	26	27	28	22
						29

Concept of Power

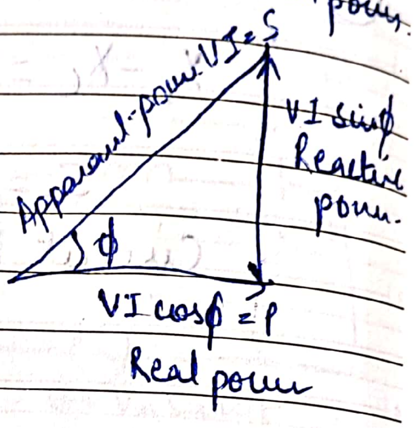
Appearent Power :- Apparent power (S) is product of rms value of voltage (V) & current (I).



$S = VI$ Unit KVA

Active | True Power or Real power :-

True Power (P) is product of applied Voltage (V) and active component of current (I).



$P = VI \cos\phi = S \cos\phi$ Unit - KW

Reactive Power :-

Reactive Power (Q) is product of applied voltage (V) & reactive component of current (I)

SUNDAY 22

Important Notes

$Q = VI \sin\phi = S \sin\phi$ unit = KVAR

Power factor

- Power factor is ratio b/w true power & apparent power.
- Ratio of resistance to Impedance.
- cosine of phase angle b/w Voltage & current

Cause of low Power factor:

- All AC motor transformers has low power factor.
- Most of the loads has low power factors.
- Industrial heating furnace, induction furnace has low power factor.

Improvement of Power factor.

- Using Phase advancers.
- Using Capacitor Bank, Synchronous Condensers.

Important Notes

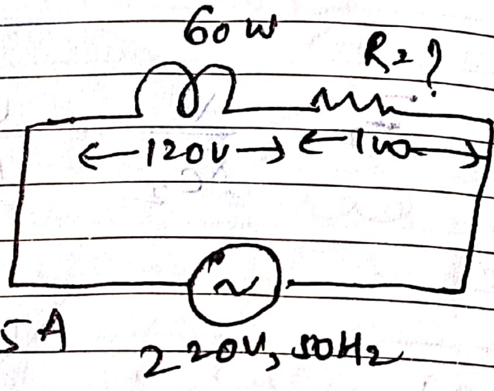
Effects of low p.f.:

- large copper losses b) large KVA rating c) Poor Voltage Regulation.

Numericals of series.

Q. A 120 V, 60 W lamp is to be operated on 220V, 50 Hz supply mains. In order that lamp should operate on correct voltage. Calculate value of (i) Non Inductive resistance. (ii) Pure inductance (iii) Pure capacitance.

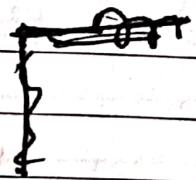
Lamp is also resistive.



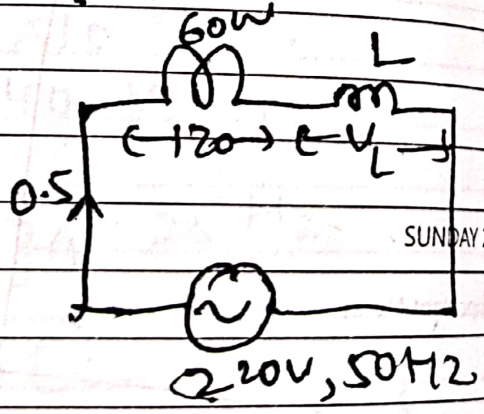
Sol:- (i) lamp $P = 60W$, $V = 120V$

$$i = \frac{P}{V} = \frac{60}{120} = \frac{1}{2} = 0.5A$$

The value of R



$$R = \frac{V}{I} = \frac{100}{0.5} = 200\Omega$$



(ii)

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

Important Notes

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

$$= \sqrt{220^2 - 120^2}$$

$$= 184.39V$$

SUNDAY 29

$$X_L = \frac{V_L}{I_L} = \frac{184.89}{0.5} = 368.78\,\Omega$$

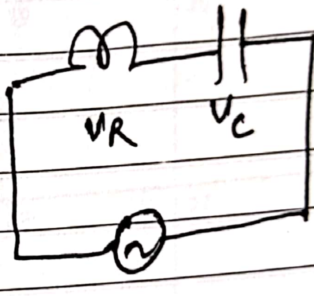
$$X_L = 2\pi f L$$

$$\cancel{X_L} = \cancel{2\pi} \quad L = \frac{X_L}{2\pi f} = \frac{368.78}{2\pi \times 50} = 1.17\,H$$

(iii) $V_C = \sqrt{V^2 - V_R^2}$

$$= \sqrt{220^2 - 120^2}$$

$$= 184.39\,V$$



$$X_C = \frac{V_C}{I_C} = \frac{184.39}{0.5} = 38.78\,\Omega$$

$$X_C = \frac{1}{2\pi f C} \quad C = \frac{1}{2\pi f X_C} = 8.63\,\mu F$$

Important Notes