UNIT-2 (A.C. Circuits)

Que.1> For a given A.C. Voltage

$$V = 200\sqrt{2}\sin(100\pi t - 30^\circ)$$

find (i) Max value (ii) r.m.s Value (iii) frequency (iv) Phase angle (v) average value (vi) Angular velocity (vii) Form & Peak Factor

Ans.> $V = 200\sqrt{2}\sin(100\pi t - 30^\circ)$

general eq. $V = V_m \sin(\omega t - \phi)$

on compairing → $V_m = 200\sqrt{2}$

$\omega = 100\pi$

$\phi = 30^\circ$

(i) Max Value $V_m = 200\sqrt{2}$

(ii) R.m.s. Value $V_{rms} = V_m/\sqrt{2} = 200$

(iii) $\omega = 2\pi f = 100\pi$

$f = 50$ Hz.

(iv) $\phi = 30^\circ$ Phase angle $= 30^\circ$

(v) $V_{av} = \frac{2V_m}{\pi} = \frac{400\sqrt{2}}{\pi}$

(vi). angular velocity ⇒ $\omega = 100\pi$ rad/sec.

(vii) Form Factor $= \frac{V_{rms}}{V_{av}} = \frac{V_m/\sqrt{2}}{2V_m/\pi} = 1.11$

Peak Factor = 1.414

Que.2> Explain form factor & Crest or Peak factor.

Ans.> (a) Form Factor → The ratio of Effective or R.M.S Value to Average Value is known as Form Factor

$$\text{Form Factor} = \frac{\text{R.M.S Value of A.C}}{\text{Average Value of A.C}}$$

(b) Peak Factor → The ratio of Max. Value to R.M.S. Value is known as peak or Crest Factor.

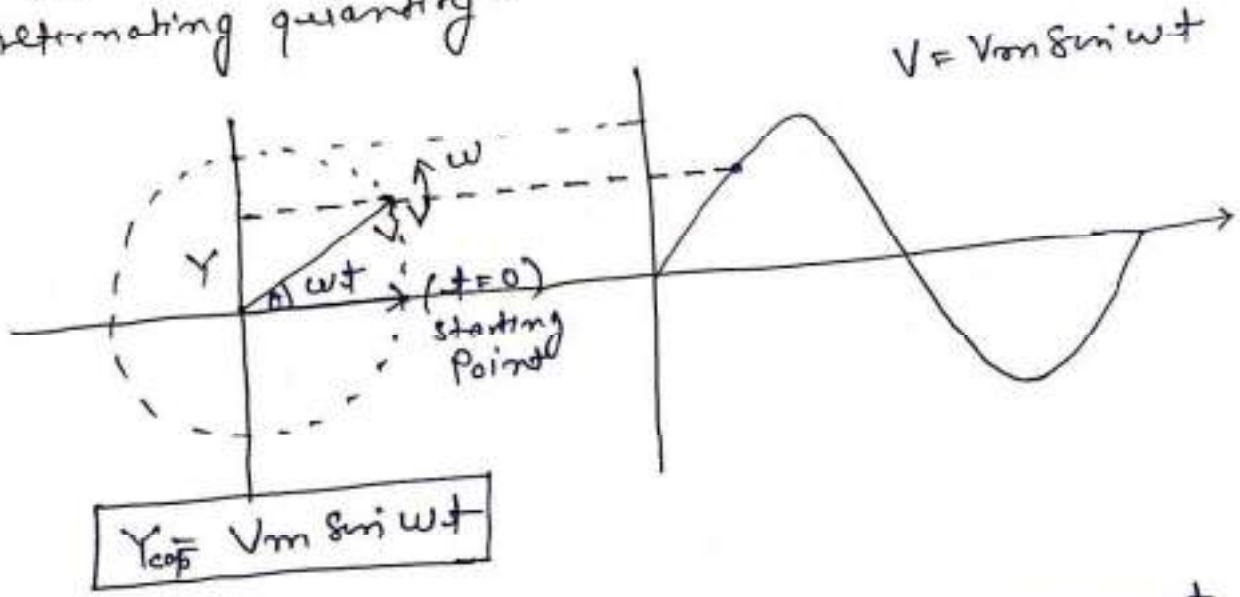
$$\text{Peak Factor} = \frac{\text{Maximum Value of A.C}}{\text{R.M.S Value of A.C.}}$$

Ques.3> What is The Physical Significance of Phasor.

Ans.> As we know Alternating quantities change its Magnitude and Direction Continuously So Mathmatical analysis of A.C. is very Complicated For Representing A.C. we use Phasor Method for Simplicity of Mathmatical analysis

Phasor> Phasor is basically a Rotating line whose Magnitude is equal to R.M.S value of alternating quantity and which is Rotating in anticlockwise direction with angular velocity ω.

" Y component of Phasor gives the instantaneous Value of particular Alternating quantity. the starting point ($t=0$) of Phasor depend upon the equation of Alternating quantity "



* For Mathmatical Analysis we represent Phasor at ($t=0$) only and this is used for addition and Substraction of alternating quantities.

Ques 4> Represent following Alternating quantities in phasor Form then Find the resultant of All.

$V_1 = 100 \sin 500t$

$V_2 = 200 \sin(500t + 45)$

$V_3 = -50 \cos 500t$

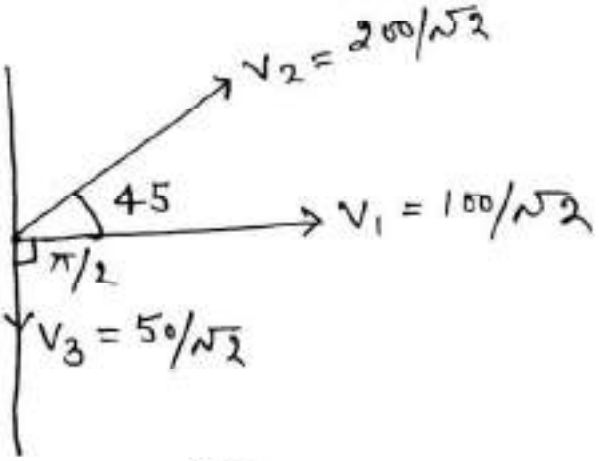
Ans.→ For analysis all quantities must in Phasorform

$V_1 = 100 \sin 500t$

$V_2 = 200 \sin(500t + 45)$

$V_3 = 50 \sin(500t - \pi/2)$

Phasor Representation>



Addition >

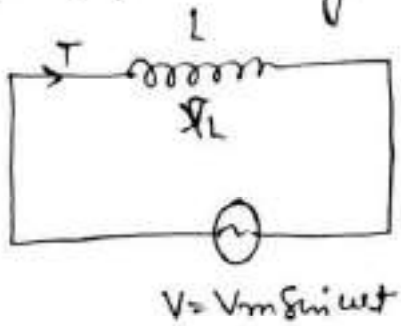
	V_x	V_Y
V_1	100	0
V_2	$100\sqrt{2}$	141.42
V_3	0	−50
V_R	241.42	91.42

$V_R = \sqrt{V_x^2 + V_Y^2} = V_{rmax} = 258.15\ V$

$\tan\phi = \frac{91.42}{241.42}$ $\quad \phi =$

Ques.5> Prove that in purely Inductive & Capacitive ckt Power Consumed is zero.

Ans.> (i) Purely Inductive ckt →



⇒ When alternating current flow Through the Inductor an e.m.f. known as self Induced e.m.f. is Induced across the Inductor and this Induced e.m.f. appose the applied Voltage and is given by

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

$$V = -e_L$$

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

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

Integrating both sides

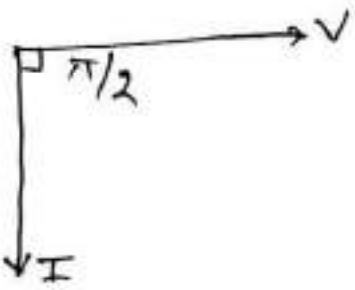
$$\int di = \int \frac{V}{L}\,dt$$

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

$$I = \frac{Vm}{\omega L}\sin(\omega t - \pi/2)$$

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

$$Im = \frac{Vm}{\omega L} = \frac{Vm}{X_L}$$



Now Instantaneous Power I

$$P_{in} = VI$$

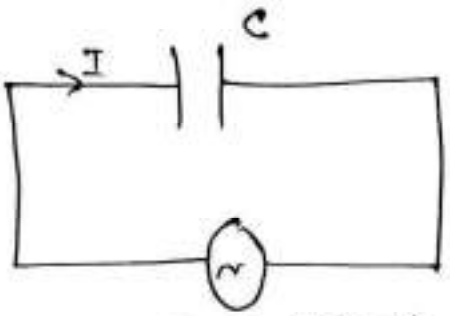
$$= Vm \sin \omega t\, Im \sin(\omega t - \pi/2$$

$$P_{in} = \frac{Vm\,Im}{2}\sin 2\omega t$$

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

because average Value of $\sin 2\omega t$ in half cycle is zero.

(ii) Purely Capacitive circuit >



at particular time Charge stored in Capacitor is given by

$$Q = CV$$

$$Q = C V_m \sin \omega t$$

now

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

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

$$I = V_m \omega C \sin(\omega t + \pi/2)$$

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

where $X_C \rightarrow$ Capacitive reactance

* Now Instantaneous power across Capacitor

$$P_{in} = VI$$

$$= V_m \sin \omega t \; I_m \sin(\omega t + \pi/2)$$

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

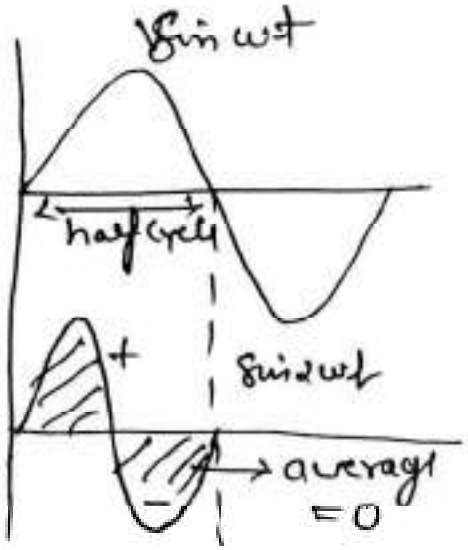
$$\boxed{P_{in} = \frac{V_m I_m}{2} \sin 2\omega t}$$

+ now average power →

$$P_{av} = 0$$

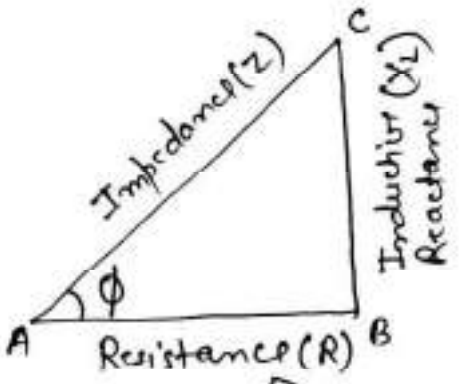
because average Value of Sin 2ωt in half cycle is zero

→



Ques·6 → Explain Impedance Triangle with Suitable Diagram.

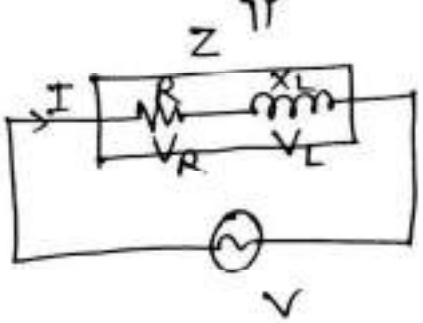
Ans. → When Resistance, Inductance and Impedance are Represented by Three Sides of Right angle triangle Such a Triangle is known as Impedance Triangle.



$$AB = \frac{V_R}{I} = R$$

$$BC = \frac{V_L}{I} = X_L$$

$$AC = \frac{V}{I} = Z$$



* the angle b/w AB & AC is known as Phase angle

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

* $\cos\phi$ is the Power Factor of the Circuit.

Ques·7 → Discuss about Apparent, True and Reactive Power.

Ans. → (i) Apparent Power → The Product of r.m.s value of Voltage & current is known as apparent Power.

$$\boxed{P_a = VI}$$

unit → V-A or KVA (Volt-Ampere)

(ii) True Power → When Apparent Power is multiply by power Factor then this Product is known as True Power

$$\boxed{P_T = VI\cos\phi}$$

unit W or KW (Watt) or (Kilowatt)

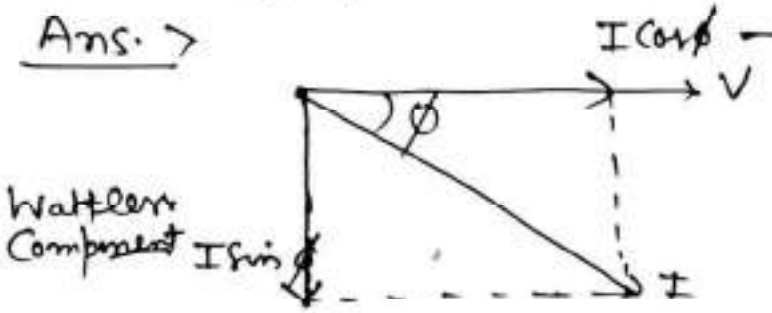
(iii) Reactive Power → The Product of apparent Power to the Sine of angle b/w Voltage and current is known as Reactive Power.

$$\boxed{P_R = VI\sin\phi}$$

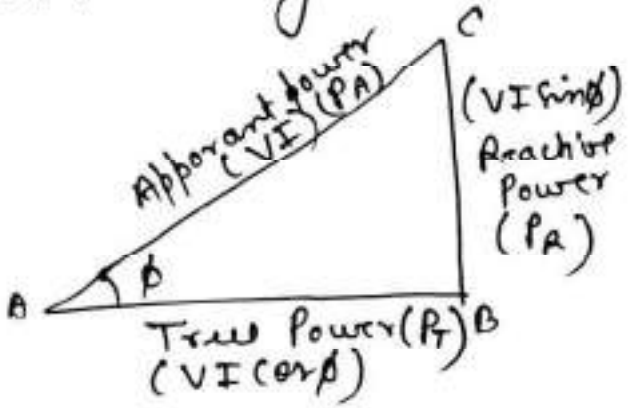
unit VA or KVAR (Volt-Ampere Reactive)

Ques 8 → Explain Power Triangle the Discuss about Watt and Wattless Component of current.

Ans. >



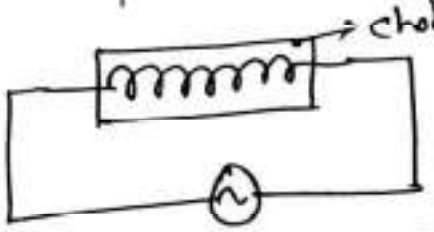
* The Component of current in phase with Voltage is known as active component or in Watt Component of current because it is Responsible for Power Consumption
* Wattless Component → The Component of current quadrature To Voltage is called Wattless Component it does not consume any Power.



$$P_A = \sqrt{P_T^2 + P_R^2}$$

Ques. 9 > Explain choke coil then define quality Factor.

Ans. >



" A coil having high Inductance and low resistance is known as choke coil "

Power loss in choke coil = Iron loss + Copper loss

Q Factor → Reciprocal of Power Factor is known as quality Factor

$$Q = \frac{1}{\cos\phi}$$

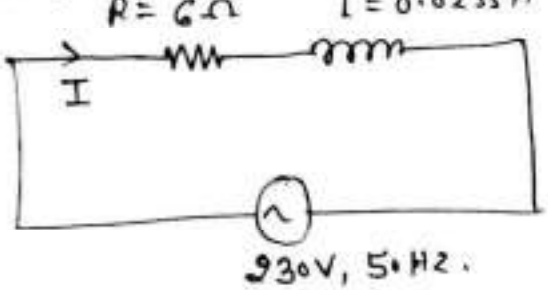
" The quality Factor of choke coil is very high "

because $\phi \to 90°$

Qu.9→ A coil having Resistance 6Ω and Inductance 0.0255 H is Connected across 230V, 50 Hz. A.C. Supply Calculate:

(i) Impedance of coil (ii) Current in circuit (iii) Power factor (iv) Power Consume (v) Instantaneous Value of Voltage & Current (vi) Apparent & Reactive power

Ans:→



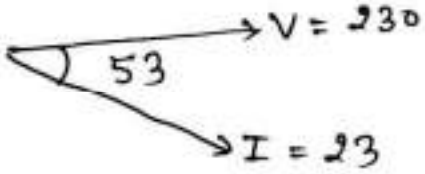
$X_L = 2\pi f L$
$= 2 \times 3.14 \times 50 \times 0.0255$
$= 8\Omega$

(i) $Z = \sqrt{R^2 + X_L^2} = \sqrt{6^2 + 8^2} = 10\Omega$

(ii) $I = V/Z = \frac{230}{10} = 23\,A$

(iii) $\cos\phi = R/Z = 0.6 \quad \phi = 53$

(iv) $P = VI\cos\phi$
$= 230 \times 23 \times 0.6 = 3174\,W$

(v) 

$V = 230\sqrt{2}\sin\omega t$

$I = 23\sqrt{2}\sin(\omega t - 53)$

(VI) Apparent & Reactive Power

⇒ Apparent $P_A = VI$
$= 230 \times 23 = 5290\,VA$
$5.290\,KVA$ Ans

⇒ Reactive power $= VI\sin\phi$
$= 230 \times 23 \times 0.8$
$= 4232\,VAR$
$= 4.232\,KVAR$ Ans.

Que.10→ The Instantaneous Value of Voltage and current in particular circuit is given by

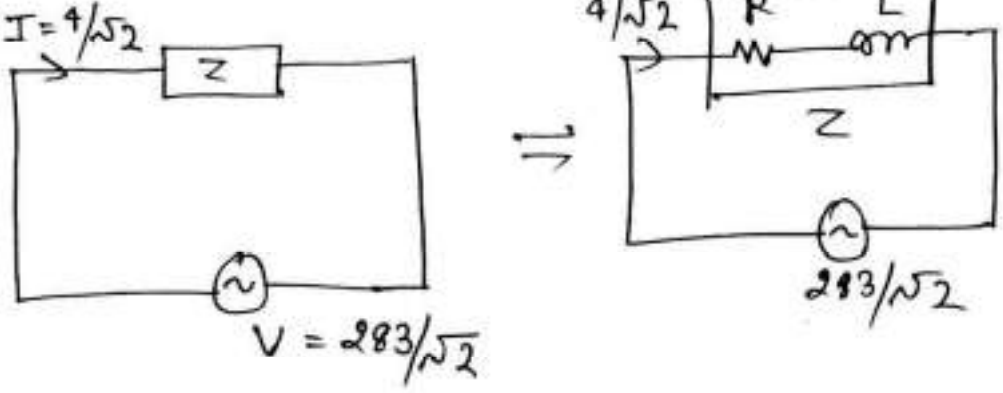
$V = 283 \sin 314t$

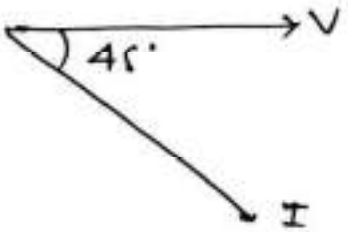
$I = 4 \sin (314t - 45^\circ)$

find (i) Circuit elements & their Value

(ii) Power factor and Power Consumed by ckt.

Ans.→





The current is lag behind the supply voltage by 45° So Circuit Contain R & L

now $Z = V/I = \frac{283/\sqrt{2}}{4/\sqrt{2}} = \underline{70.75\Omega}$ Ans

$\cos\phi = R/Z$ So $R = Z\cos\phi$

$= 70.75 \cos 45$

$= 50\Omega$

$X_L = Z \sin\phi$

$= 50\Omega$

$2\pi fL = 50\Omega \Rightarrow L = 50/2\pi f = \underline{0.159\,H}$ Ans

(ii) Power Factor $\Rightarrow \cos\phi = \cos 45 = 0.707$ (lagging)

$P = VI\cos\phi$

$= \frac{283}{\sqrt{2}} \times \frac{4}{\sqrt{2}} \times 0.707$