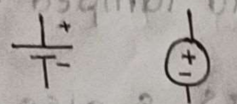
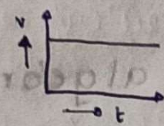
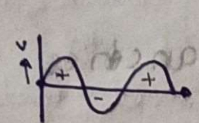
24/11/22

Unit-3 :- Single phase AC circuits (1-ϕ circuits)

 DC Representations..

* AC wave :-

For DC →  {independent of time}

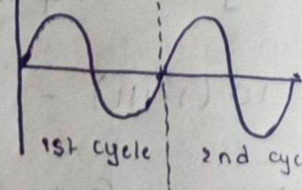
For AC →  {dependent of time}

* The magnitude of alternating quantity & its direction changes with respect to time & polarity changes {alternating quantity fluctuates}

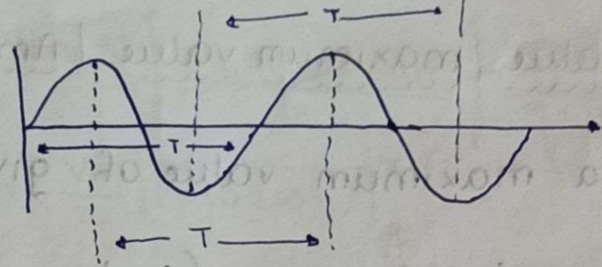
→ This type of wave is called AC wave.

 → AC representation

* Cycle : cycle is a part of wave which contains positive, negative & 0 values which repeats uniformly.



* Time period : Time taken to complete one cycle is called Time period (T). Represented by 'T'



* Frequency: (f) is equal to no. of cycles per unit time, measured in Hertz.

$$f = \frac{\text{no. of cycles}}{\text{time}} \quad \& \quad 1\,Hz = \frac{\text{one cycle}}{1\,sec}$$

* Indian current frequency = 50 Hz
* US supply frequency = 60 Hz

Q. A time period of alternating wave is 30 sec. What is its frequency... $f = \frac{1}{30} = \boxed{0.03\ Hz}$ $\{f = \frac{1}{T}\}$

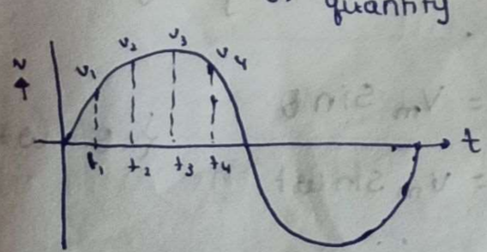
Q. A time period of AC wave is 20 milli seconds. What is its frequency → $f = \frac{1000}{20} = \underline{50 Hz}$ $\{f = \frac{1}{T}\}$

Q. An Alternating wave has 50 Hz frequency. What is its time period. → $T = \frac{1}{f} = \frac{1}{50} = 0.02$ sec.

20 m sec (milli).

* Instantaneous values:

The values of quantity at particular instant of time



v_1, v_2, v_3 & v_4 are instanteous voltages

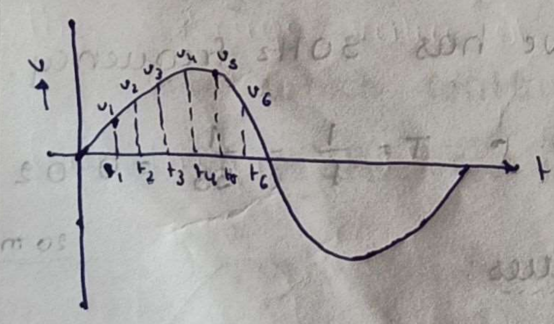
* Peak value / maximum value / Amplitude:

It is a maximum value of given wave is the amplitude of wave (highest value) (crest value)

* Average value of AC wave:

It can be defined as, "when DC source is connected to circuit & we calculated the charge transfered for 't' time, then the charge transfered by the AC circuit source is as same as charge transfered by DC source calculated for the same time 't' is known average value of AC wave."

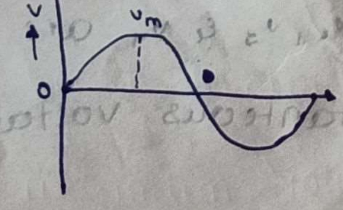
1) Graphical method for finding Avg:



$$\text{Avg} = \frac{v_1 + v_2 + v_3 + \dots + v_n}{n}$$

v voltage

2) Analytical method for finding Avg:

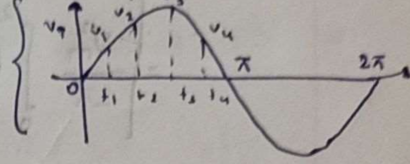


$V = V_m \sin\theta$

$V = V_m \sin\omega t$

$\{\theta = \omega t\}$

Now $V_{avg} = \int_0^{\pi} \frac{V_m \sin\omega t \, d\omega t}{\pi}$



$V_{avg} = \frac{V_m}{\pi}\left[(-\cos\omega t)\right]_0^{\pi}$

$V_{avg} = \frac{V_m}{\pi}\left[-\cos\pi + \cos 0\right]$

$V_{avg} = \frac{2V_m}{\pi}$

$\boxed{V_{avg} = 0.636\ V_m}$ Similary $I_{avg} = 0.636\ I_m$

V_m = maximum value of voltage

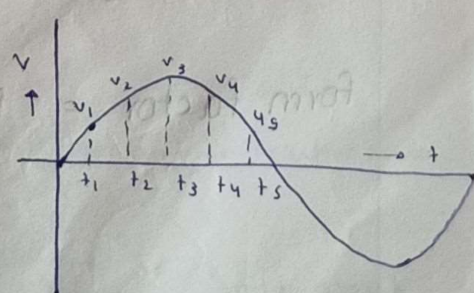
I_m = maximum value of current.

* RMS value of an AC wave (Root Mean Square):-

→ The value obtained when heat produced by DC supply must be equal to the heat produced by AC supply calculated for same circuit & in same time. is rms value.

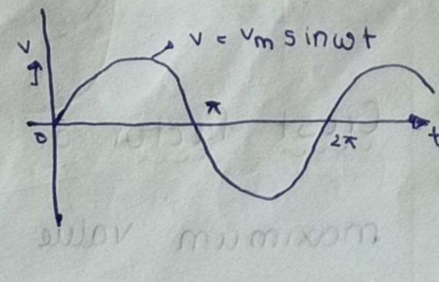
① Graphical method

$$V_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + v_3^2 + \dots v_n^2}{n}}$$



② Analytical method

$$V_{rms} = \sqrt{\int_0^{2\pi} \frac{V_m^2 \sin^2 d\omega t}{2\pi}}$$



$$= \left[\frac{V_m^2}{2\pi} \int_0^{2\pi} \left(\frac{1-\cos 2\omega t}{2}\right) d\omega t\right]^{1/2}$$

$$= \left\{\frac{V_m^2}{4\pi} \cdot \left[\omega t\Big|_0^{2\pi} - \frac{\sin 2\omega t}{2}\Big|_0^{2\pi}\right]\right\}^{\frac{1}{2}}$$

$$= \left\{\frac{V_m^2}{4\pi}\left[2\pi - \left(\frac{\sin 2\pi}{2} - \frac{\sin 0}{2}\right)\right]\right\}^{\frac{1}{2}}$$

$$= \left(\frac{V_m^2}{\cancel{4\pi}_2} \cancel{2\pi}\right)^{\frac{1}{2}}$$

$$= \frac{V_m}{\sqrt{2}}$$

$$= 0.707\, V_m$$

$\therefore \boxed{V_{rms} = 0.707\, V_m}$ V_m = Maximum value of voltage.

Similarly $\boxed{I_{rms} = 0.707\, I_m}$

* Form factor : The ratio of rms value & the average value of the quantity is called

$$\text{form factor} = FF = \frac{\text{Rms value}}{\text{Avg value}}$$

$$= \frac{0.707\, V_m}{0.636\, V_m}$$

$$= \underline{\underline{1.11}}$$

* Crest factor or peak factor: The ratio of maximum value to the rms value is peak factor

$$PF = \frac{\text{Max value}}{\text{Rms value}}$$

$$PF = \frac{V_m}{0.707 V_m} = 1.414.$$

* Power factor: Represented by $\cos\phi$. power factor is the cosine angle between voltage & current.

* Active power :- / V_L power or / true power

→ Active power $\boxed{(P) = VI\cos\phi}$ in watts.

* The power consumed by active elements in a circuit having different elements is called Active power.

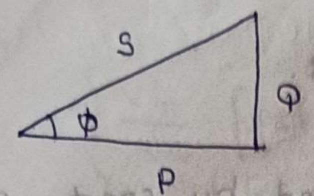
* Reactive power / Imaginary power (Q) :. The power consumed by reactive elements in a circuit having different elements is called passive power.

$\boxed{Q = VI\sin\phi}$ (VAR) volt ampere reactive power.

* Apparent power : (S) :. $\boxed{S = VI}$ { Volt amp }

The power given to apparent devices is known as apparent power :

* **Power triangle :-**



$$S = \sqrt{P^2 + Q^2}$$

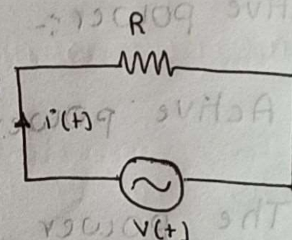
$$P = \sqrt{S^2 - Q^2}$$

$$Q = \sqrt{S^2 - P^2}$$

By, power triangle $\cos\phi = \frac{P}{S}$

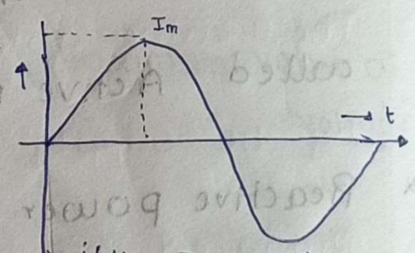
* **AC through Resistor :**

Consider a resistance R resistor and voltage source connected in series. Current flowing is $i(t)$.



* Here impedance (z) = Resistance (R).

$$\underline{\underline{Z = R}}$$



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

Now, we have

$V(t) = I_m \cdot Z \cdot \sin\omega t$

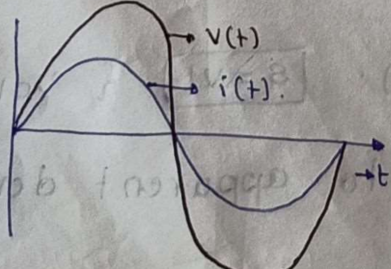
$V(t) = V_m \cdot \sin\omega t$

$v(t) = V_m \sin\omega t$

$\boxed{V_m = I_m \cdot Z}$

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

z = impedance.



Here phase difference

$\phi = 0$.

* For a resistive circuit, the phase angle b/w

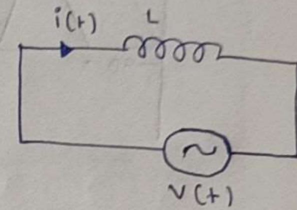
voltage & current is zero., so

power factor = $\cos\phi = \cos 0^{\circ} = 1$

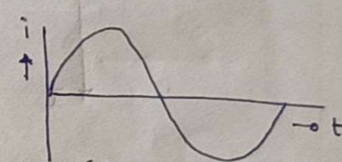
* Phasor diagram { $\xrightarrow{I} \xrightarrow{V}$ } phase angle $\phi = 0^{\circ}$

* Ac through pure inductor :

Consider a inductor of inductance (L) & AC source connected in series.



Assume that current flowing in inductor is sinusodial current



$i(t) = I_m \sin\omega t$.

* voltage across inductor

is $V(t) = L \cdot \frac{di(t)}{dt}$

$V(t) = L \cdot \frac{d}{dt}(I_m \sin\omega t)$

$V(t) = I_m \cdot L \cdot \omega \cos\omega t$

$V(t) = I_m \cdot L \cdot \omega \sin(\omega t + 90)$

$V(t) = V_m \sin(\omega t + 90) \rightarrow ①$

$\boxed{V_m = I_m \cdot \omega \cdot L}$ $\{ X_L = 2\pi f \cdot L \}$

where $\omega L = X_L$ { inductive reactance (Ω) }

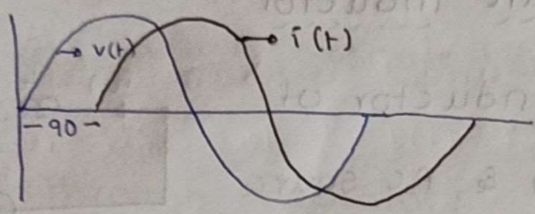
* For practical inductor , $Z = R + jX_L$

* For pure inductor, $Z = jX_L$

From ①

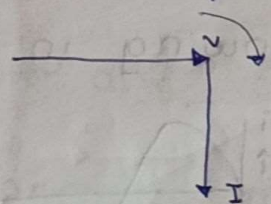
$V(t) = V_m \sin(\omega t + 90)$ & also

$I(t) = I_m \sin \omega t$, so graph is...



the phase angle is $\phi = 90°$

* Vector representation / phasor diagram.



{ current lags with voltage by 90°

* We know impedance $Z = \frac{V(t)}{i(t)} = \frac{I_m \cdot \omega \cdot L \cdot \sin(\omega t + 90)}{I_m \sin \omega t}$

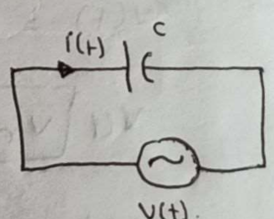
$= \omega L \angle 90°$

$= X_L \angle 90°$

for pure inductor $\boxed{Z = jX_L}$

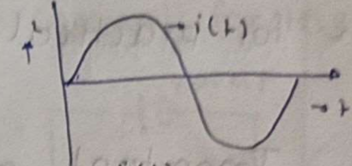
* AC through pure ~~indu~~ capacitor :.

* Consider capacitor of capacitance 'c' & voltage AC source connected in series.



* Assume current flowing through circuit is sinusodial current.

we know $i(t) = C \cdot \frac{dv(t)}{dt}$



$\rightarrow v(t) = \frac{1}{C} \int i(t)\, dt.$

$\rightarrow v(t) = \frac{1}{C} \int I_m \sin\omega t \, dt$

$= \frac{I_m}{\omega C} [-\cos\omega t]$

$= \frac{I_m}{\omega C} \sin(\omega t - 90^\circ)$

$v(t) = V_m \sin(\omega t - 90) \rightarrow ①$

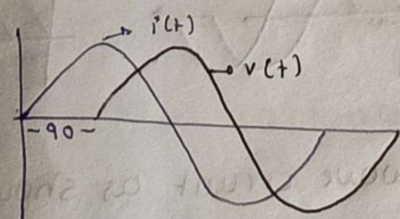
$\left\{ \begin{array}{l} \frac{1}{\omega C} = X_C \\ X_C = \frac{1}{2\pi f C} \ (\Omega) \end{array} \right.$

we have

$\left\{ X_C = \text{capacitive reactance} \right.$

$v(t) = V_m \sin(\omega t - 90)$

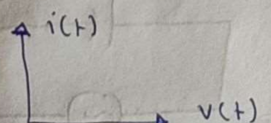
$i(t) = I_m \sin\omega t$, so graph is..



the phase angle

$\phi = 90^\circ$

vector representation / phasor diagram



current leads voltage by 90°

* we know impedance $z = \frac{v(t)}{i(t)} = \frac{\frac{I_m}{\omega C} \sin(\omega t - 90)}{I_m \sin\omega t}$

$z = \frac{1}{\omega C} \frac{\sin(\omega t - 90)}{\sin\omega t}$

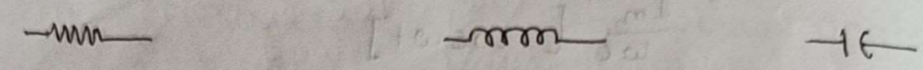
$z = X_C \angle -90^\circ$

$\boxed{z = -jX_C}$ for pure capacitor.

* for practical capacitor, $\boxed{Z = R - jX_C}$ {R is low}.

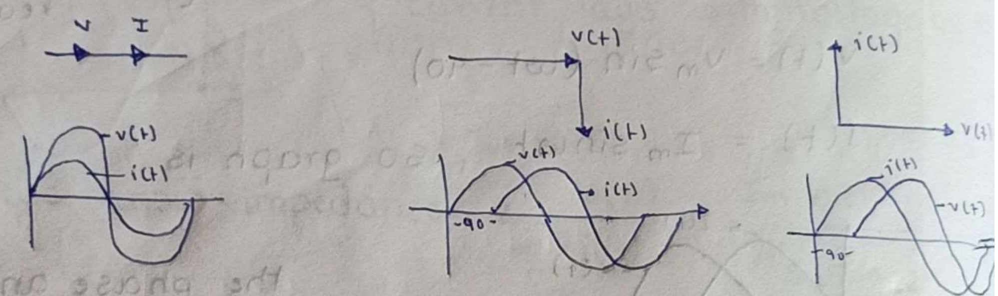
Important points :

	Resistor	inductor	capacitor.
Symbol			
I(t)	$I(t) = I_m \sin\omega t$	$I(t) = I_m \sin\omega t$	$I(t) = I_m \sin\omega t$
v(t)	$V(t) = V_m \sin\omega t$	$V(t) = V_m \sin(\omega t + 90)$	$V(t) = V_m \sin(\omega t -$
power factor	unity	lag	lead

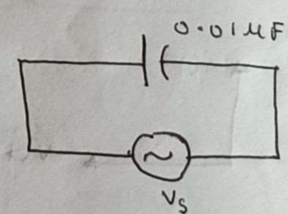


phasor

sinewave



Q For a sinusodial wave circuit as shown in fig. The frequency of sine wave is 2 K Hz. Determin the capacitive reactance.



A $F = 2\,KHz$

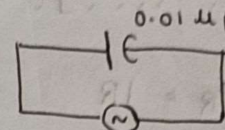
$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

$$X_C = \frac{1}{2(3.14)(2000)(0.01 \times 10^{-6})}$$

$$X_C = 7.96 \times 10^3\ \Omega$$

$$X_C = 7.96\ K\Omega$$

Q Determine the rms value of current for the circuit shown.



$V_{rms} = 5V$

$f = 5 kHz.$

A $X_c = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

$= \frac{1}{2\pi (5\times10^3)(0.01\times10^{-6})}$

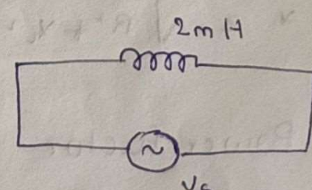
$= 3.18 \times 10^3 \Omega$

$= 3.18 \, k\Omega = X_c.$

Now $I_{rms} = \frac{V_{rms}}{X_c}$ $\{ Z = X_c \}$

$I_{rms} = \frac{5V}{3.18\times10^3} \rightarrow \boxed{I_{rms} = 1.57 \, mA}$

Q A sinusodial voltage is applied to given circuit with a frequency of 3kHz. find the inductive reactance.



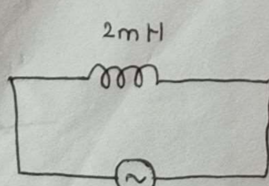
A $f = 3kHz$

$X_L = 2\pi f L$

$= 2\pi (3\times10^3) \cdot 2\times10^{-3}$

$= 37.69 \Omega$

Q Find the value of i_{rms} for given circuit.



$V_{rms} = 10 V$

$f = 10kHz$

A $X_L = 2\pi f L = 2\pi (10\times10^3)(2\times10^{-3})$

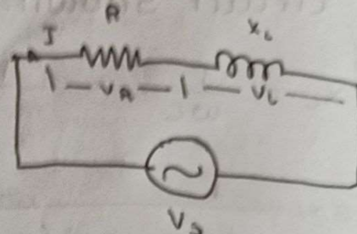
$X_L = 125.6 \Omega$

$I_{rms} = \frac{V_{rms}}{Z}$ $(Z = X_L)$ Here

$I_{rms} = \frac{10}{125.6\Omega} = \boxed{79mA}$

AC through R-L Series circuit:

* $V_R = IR$



$V_L = I.X_L$

The effective voltage

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

$V_S = \sqrt{(IR)^2 + (IX_L)^2}$

$V_S = \sqrt{I^2 (R^2 + X_L)^2}$

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

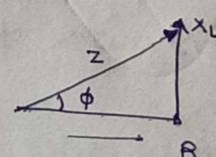
$V_S = IZ$ $\{Z = \sqrt{R^2 + X_L^2}$ (magnitude)$\}$ Ω

$\{Z = R + jX_L\ (\Omega)$ (direction & magnitude$\}$

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

Power factor

$\cos\phi = \frac{R}{Z}$

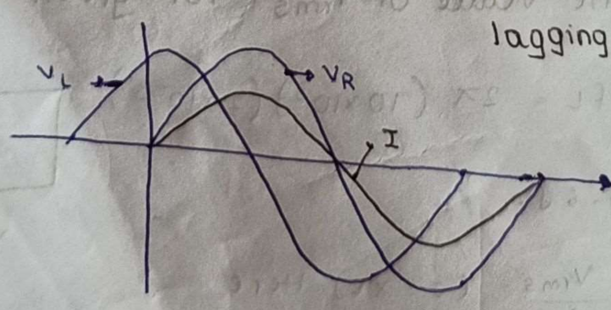


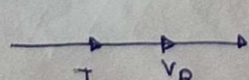
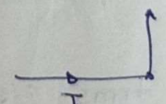
Impedance triangle

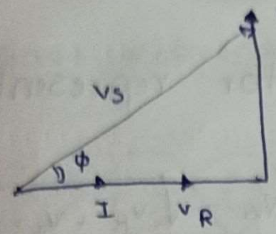
* phasor diagram or vector ~~diff~~ representation is in down

→ Now wave representation..

lagging power factor



→  for resistive circuit,  for inductive circuit



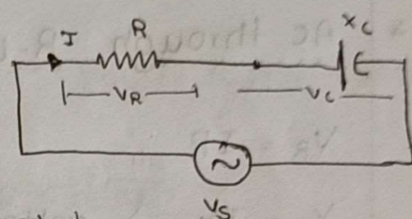
voltage triangle

$$V_S = \sqrt{V_R^2 + V_L^2}.$$

Power factor (PF) = $\cos\phi = \dfrac{V_R}{V_S}$

* AC through RC series circuit :

$V_R = IR$
$V_C = I \cdot X_C$ } voltage formulae.



* R is resistance of complete circuit ie it the ressistance of resistor + resistance of capacitor.

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

$$V_S = \sqrt{IR^2 + IX_C^2}$$

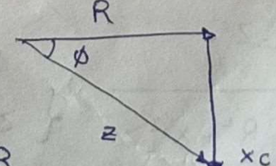
$$V_S = I\sqrt{R^2 + X_C^2}$$

$V_S = IZ$ $\quad \{Z = \sqrt{R^2 + X_C^2}$ (Here)$\}$

$\{Z = R - jX_C$ (with direction)$\}$

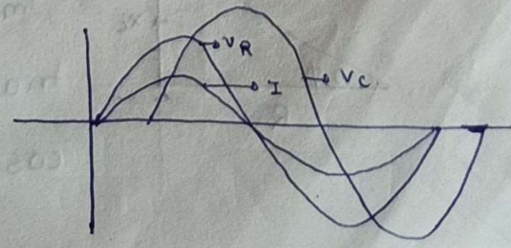
$Z = \sqrt{R^2 + X_C^2}$

Impedance trianagle



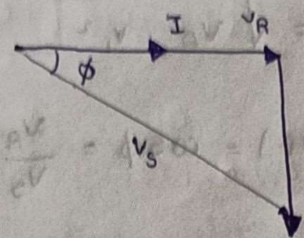
Power factor $\cos\phi = \dfrac{R}{Z}$

* wave representation



* phasor representation or vector representation

voltage triangle

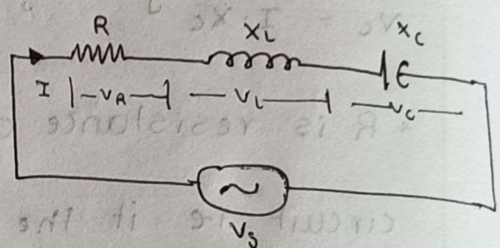


$V_S = \sqrt{V_R^2 + V_C^2}$

power factor $= \frac{V_R}{V_S}$

power factor leading

* AC through R-L-C circuit series circuit.



$V_R = IR$

$V_L = IX_L$

$V_C = IX_C$

$\left.\begin{matrix} V_R = IR \\ V_L = IX_L \\ V_C = IX_C \end{matrix}\right\}$ voltages.

* R is resistance of whole circuit

$$V_S = \sqrt{V_R^2 + (V_L \sim V_C)^2}$$

$$V_S = \sqrt{(IR)^2 + (IX_L \sim IX_C)^2}$$

$$V_S = I\sqrt{R^2 + X^2}$$

$X \rightarrow$ Net reactance

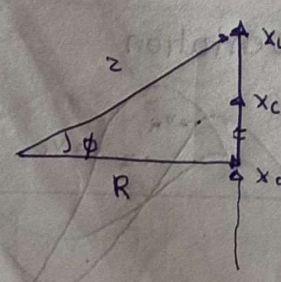
$= X_L \sim X_C$

$V_S = I \cdot Z$

$Z = \sqrt{R^2 + X^2}$ $\{ Z = R + jX \quad (X = X_L \sim X_C) \}$

$\boxed{X = X_L \sim X_C}$

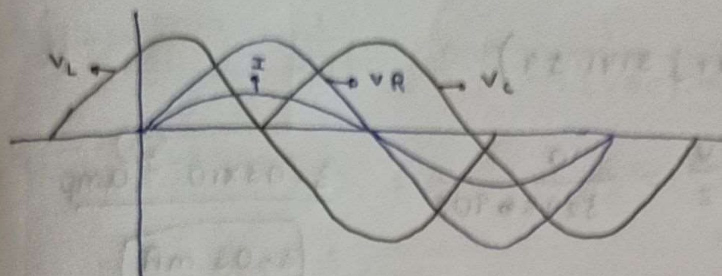
* Vector Representation



Impedance triangle

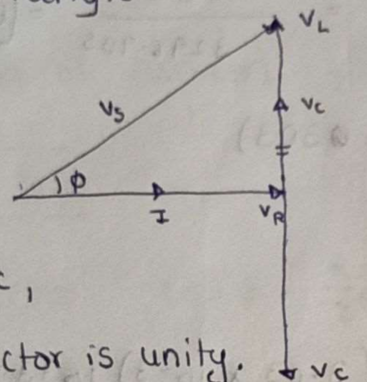
$\cos\phi = \frac{R}{Z}$

wave representation:



× vector representation:

voltage triangle



Power factor $\cos\phi$

$= \frac{V_R}{V_s}$

If $X_L > X_C$, then

Lagging power factor

If $X_C > X_L$ then

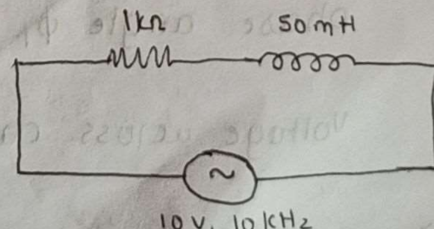
leading power factor

If $X_L = X_C$,

power factor is unity.

Q For the circuit shown below,

find the impedance z, curren I, phase angle ϕ, voltage across V_R (resistor), power factor, voltage across inductor V_L.



A Given R = 1000Ω

$L = 50 \times 10^{-3} H$,

V = 10V,

$f = 10 \times 10^3 Hz$

① $z = \sqrt{R^2 + X_L^2}$

$X_L = \omega \cdot L = 2\pi f L =$

$= 2\pi (10 \times 10^3)(50 \times 10^{-3})$

$= 3141.59\Omega$

$Z_1 = z = \sqrt{1000^2 + 3141.59^2}$

$Z = \boxed{3296.905\,\Omega}$

$z = (1000 + j\,3141.59)$

② $I = \frac{V}{Z} = \frac{10}{32966905} = 3.03 \times 10^{-3}$ amp

$= \boxed{3.03\ mA}$

③ power factor $= \cos\phi$

$\cos\phi = \frac{R}{Z} = \frac{1000}{3296.905} = \boxed{0.303 \text{ lagging}}$

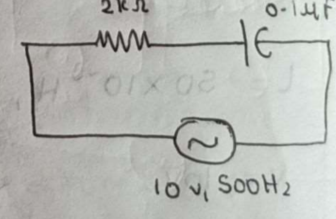
④ $\phi = \cos^{-1}(0.0303)$

$\boxed{\phi = 72.36^{\circ}}$

⑤ $V_R = IR = (3.03 \times 10^{-3})\,10^{+3} = \boxed{3.03\,V}$

⑥ $V_L = IX_L = (3.03 \times 10^{-3})(3141.59) = \boxed{9.519\,V}$

Q For the circuit shown below, find the total impedance (z), current in circuit I, powerfactor, phase angle ϕ, voltage accross resistor V_R & Voltage across capacitor V_C.



* $R = 2000\,\Omega$

$C = 0.1 \times 10^{-6}\,F$

$V = 10\,V,$

$F = 500\,Hz$

① $Z = \sqrt{R^2 + X_C^2}$

$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{1}{2\pi (500)(0.1 \times 10^{-6})}$

$X_C = 3183.09\ \Omega$

$Z = \sqrt{2000^2 + 3183.09^2}$

$\boxed{Z = 3759.26\ \Omega}$ $Z = (2000 - j3183.09)\ \Omega$

② The value of current $I = \frac{V}{Z} = \frac{10}{3759.26}$

$\boxed{I = 2.66\ mA}$

③ power factor $\cos\phi = \frac{R}{Z} = \frac{\cancel{3759.26}\ 2000}{3759.26}$

$\boxed{\cos\phi = 0.532 \text{ leading}}$

④ phase angle $\phi = \cos^{-1}(0.532)$

$\phi = \cos^{-1}(0.532)$

$\boxed{\phi = 57.85^\circ}$

⑤ voltage across resistor, $V_R = I \cdot R$

$= (2.66 \times 10^{-3})(2000) = \boxed{5.32\ V}$

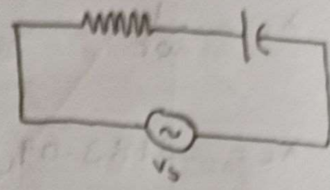
⑥ Voltage across capacitor, $V_C = I \cdot X_C$

$= (2.66 \times 10^{-3})(3183.09) = \boxed{8.467\ V}$

* Determine the source voltage & ~~phase~~ phase angle in the circuit when the voltage across resistor is 20V &

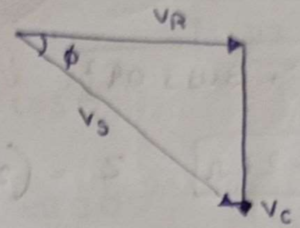
voltage across capacitor is 30V.

A $V_R = 20V$ & $V_L = 30V$



$$V_S = \sqrt{V_A^2 + V_C^2}$$

$$= \sqrt{20^2 + 30^2}$$



Voltage triangle

$$= 36.05\ V$$

$$\phi = \tan^{-1}\left(\frac{V_L}{V_R}\right)$$

$$\phi = \tan^{-1}\left(\frac{30}{20}\right)$$

$$= 56.30$$

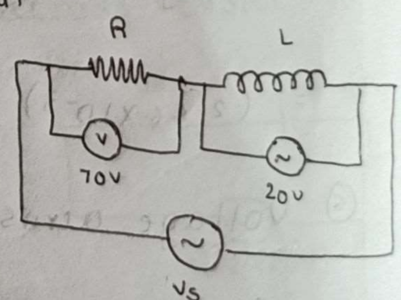
* power factor $= \cos\phi$

$= \cos(56.30)$

$= 0.554$ leading

Q Determine the source voltage, phase angle is & power factor of given circuit.

A 1) $V_R = 70V,\ V_L = 20V$

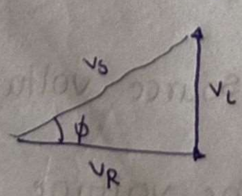


$$V_S = \sqrt{V_R^2 + V_L^2}$$

$$V_S = \sqrt{70^2 + 20^2}$$

voltage triangle

$$V_S = 72.8\ V$$



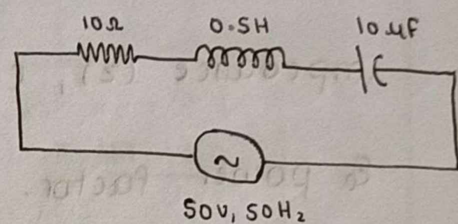
② $\phi = \tan^{-1}\left(\frac{V_L}{V_R}\right)$

$\phi = 15.94°$

③ Power factor $= \cos\phi = \cos(15.94)$

$= 0.96$ lagging.

Q In the circuit shown in figure, I, P.F, ϕ & voltage across each element in the circuit.



A $R = 10\Omega$, $L = 0.5H$, $C = 10\mu F$

$V = 50V$, $f = 50Hz$

① $Z = \sqrt{R^2 + (X_L \sim X_C)^2}$

$X_L = \omega L = 2\pi f L = 2\pi(50)(0.5)$

$X_L = 157.079\ \Omega$

$X_C = 1/2\pi f C = 1/2\pi(50)(10)\times10^{-6} = 318.30\ \Omega$

$Z = \sqrt{10^2 + (318.30 - 157.079)^2}$

$Z = \sqrt{10^2 + (161.23)^2}$

$\boxed{Z = 161.53\Omega}$ $(Z = 10 + j161.23)$ $\{Z = R + j(X_L \sim X_C)\}$

② $I = \frac{V}{Z} = \frac{50}{161.53} = \boxed{0.309\ A}$

③ power factor $\cos\phi = \frac{R}{Z} = \frac{10}{161.53} = 0.061$ leading

④ $\phi = \cos^{-1}(0.061)$

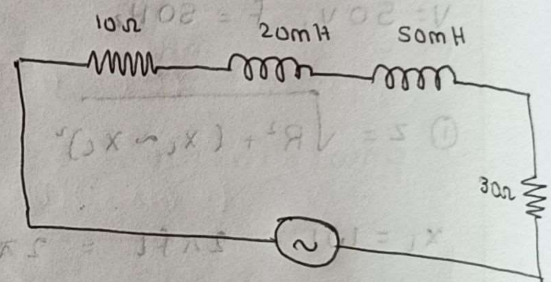
$\boxed{\phi = 86.50°}$

$\rightarrow V_R = I(R) = 0.309\,(10) = \underline{3.90V}$

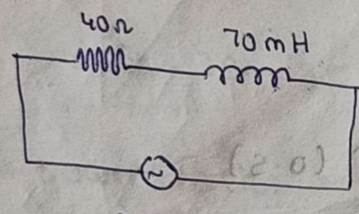
$\rightarrow V_L = I(X_L) = 0.309\,(157.07) = \underline{47.121V}$

$\rightarrow V_C = I(X_C) = 0.309\,(318.30) = \underline{95.49V}$

Q A supply voltage of 30V, 100 Hz is given to the series circuit shown in below figure. Determine impedance (Z), current in circuit I, phase angle & power factor.



A =



① $Z = \sqrt{R^2 + X_L^2}$

$X_L = 2\pi f L$

$X_L = 2\pi\,(100)\,(70\times10^{-3}) = 43.98\,\Omega$

* $Z = \sqrt{40^2 + 43.98^2}$

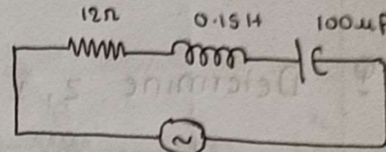
$\rightarrow Z = 59.450\,\Omega$

② $I = \frac{V}{Z} = \frac{30}{59.45} = \boxed{0.50A}$

③ $PF = \cos\phi = \frac{R}{Z} = \frac{40}{59.45} = 0.67$ Lagging

④ $\phi = \cos^{-1}(0.67) = 47.93°$

Q Determine impedance Z, current I, powerfactor, ϕ, voltage across each element of given circuit.



$V_S = 100V, 50Hz$

A $R = 12\Omega$, $L = 0.15H$

$C = 100\mu F$, $V_S = 100V$,

$f = 50Hz$.

① $z = \sqrt{R^2 + (x_L \sim x_c)^2}$

$x_L = 2\pi f L = 2\pi(50)(0.15) = \underline{47.12\Omega}$

$x_c = \frac{1}{\omega c} = 1/2\pi f c = 1/2\pi(50)(100 \times 10^{-6}) = \underline{31.83\Omega}$

$X = X_L - X_c$

$= 47.12 - 31.83$

$= 15.29\Omega$

$z = \sqrt{12^2 + 15.29^2}$

$z = 19.43$

$z = (12 + j\,15.29)\Omega$

② $I = \frac{V}{z} = \frac{100}{19.43} = \underline{5.14\,A}$

③ $PF = \cos\phi = \frac{R}{z} = \frac{12}{19.43} = 0.617$ lagging.

④ $\phi = \cos^{-1}(0.617)$

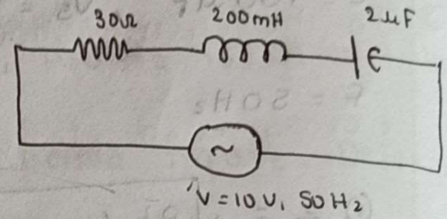
$\phi = 51.90^{\circ}$

⑤ Voltage $V_R = IR = 5.14 \times 12 = \underline{61.68}$

$V_L = IX_L = 5.14 \times 47.12 = \underline{242.19V}$

$V_c = IX_c = 5.14 \times 31.03 = \underline{163.60V}$

Q Determine Z, I, ϕ, V_R, V_L & V_c in given circuit



A $R = 30\Omega$, $L = 200mH$

$C = 2\mu F$, $V = 10V$, $f = 50Hz$

① $Z = \sqrt{R^2 + (X_L \sim X_c)^2}$

$X_L = 2\pi f L = 2\pi(50)(200\times10^{-3}) = 62.83\Omega$

$X_c = 1/2\pi f C = 1/2\pi(50)(2\times10^{-6}) = 1591.5\Omega$

$X = X_C - X_L$

$X = 1591.5 - 62.83 = 1528.67\Omega$

$Z = \sqrt{30^2 + 1528.67^2}$

$\underline{\underline{Z = 1528.96\Omega}}$ $(Z = 30 + j1528.62)$

② $I = \frac{V}{Z} = \frac{10}{1528.96} = 0.00654A$

$= 6.54\,mA$

③ $PF = \cos\phi = \frac{R}{Z} = \frac{30}{1528.96} = 0.019$ leading

④ $\phi = \cos^{-1}(0.019)$

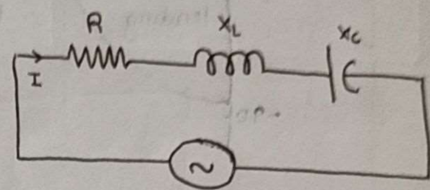
$= 88.91°$

$V_R = 0.00654 \times 30 = \underline{0.196V}$

$V_L = 0.00654 \times 62.83 = \underline{0.40V}$

$V_C = 0.00654 \times 1591.5 = \underline{10.40V}$

* RLC Series resonance :



(i) If $X_L > X_C$, PF lagging

$X_L = 2\pi f L$

Inductive circuit $X_L \propto f$ {f is frequency}

(ii) If $X_C > X_L$

capacitive circuit, $X_C \propto \frac{1}{f}$ $\left\{ X_C = \frac{1}{2\pi f C} \right\}$

PF leading.

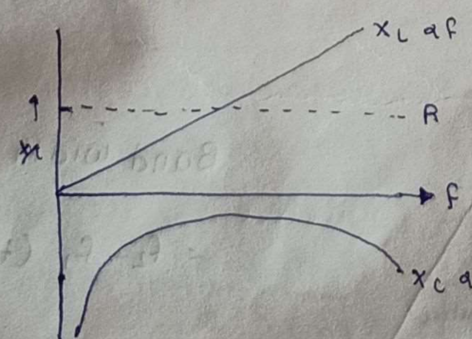
* If $X_L = X_C$, the circuit is said to be in resonance

Here $Z = R$, net reactance $= 0$ is..

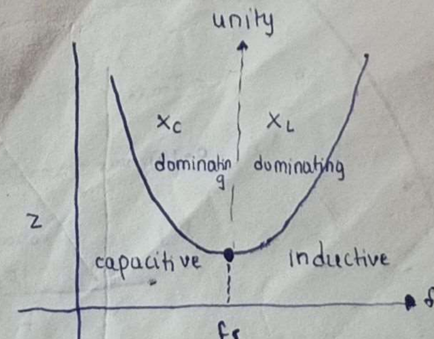
* $2\pi f_r L = \frac{1}{2\pi f_r C}$

$f_r = \frac{1}{2\pi\sqrt{LC}}$ Hz $\{f_r = $ resonance frequency$\}$

* Graphs : frequency Vs impedance.

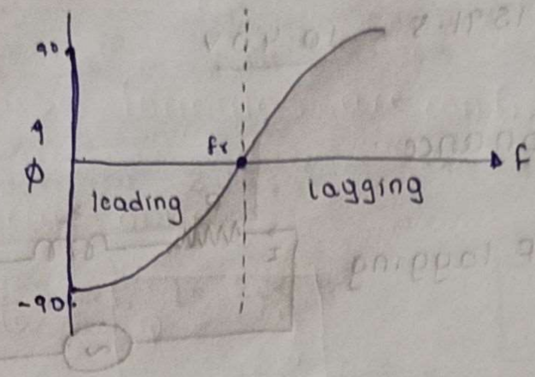


combination of all 3 :

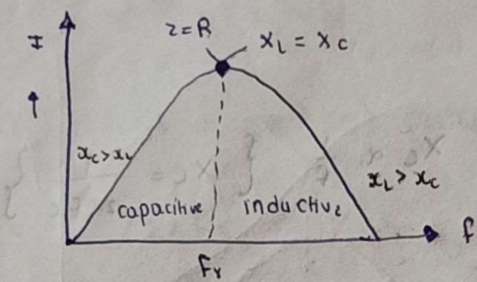


f_r = resonant frequency.

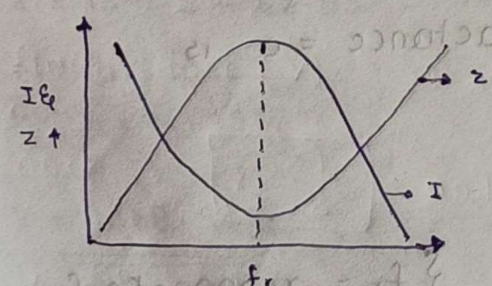
frequency Vs phase angle ϕ:



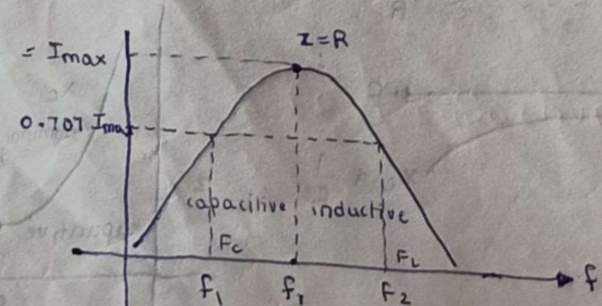
frequency Vs current:



frequency Vs I & Z



* Band width : Range of frequency which is at the 2 points matches with the voltage and current



Band width

$= f_2 - f_1$ (Hz)

Band width $= f_2 - f_1 = \frac{R}{2\pi L}$ {formula}

$$f_r - f_1 = \frac{R}{4\pi L}$$

$$f_2 - f_r = \frac{R}{4\pi L}$$

$$f_1 = f_r - \frac{R}{4\pi L}$$

$$f_2 = f_r + \frac{R}{4\pi L}$$

* Bandwidth of RLC circuit.

* Quality factor: It is the ratio of electric energy stored in the reactive part of the circuit and energy dissipated in the capacitive part of the circuit calculated for one period.

$$Q = \left[2\pi \times \frac{1}{2} L I^2\right] / \left[(I/\sqrt{2})^2 R t\right]$$ watts.

$$Q = \frac{2\pi \times \frac{1}{2} L I^2}{\frac{I^2}{2} R \left(\frac{1}{f}\right)} \quad \left\{t = \frac{1}{f}\right\}$$

$$Q = \frac{2\pi L f}{R} = \frac{\omega L}{R} = \frac{X_L}{R}$$

$\boxed{Q = \frac{X_L}{R}}$ (no units). {in inductor} or capacitor & resistor are given

* In capacitive circuit → $Q = \frac{2\pi \frac{1}{2} C V^2}{\frac{I^2}{2} R \left(\frac{1}{f}\right)}$

$$Q = \frac{2\pi C (I^2 X_c^2)}{I^2 R \left(\frac{1}{f}\right)} \quad \{V = I X_c\}$$

$$Q = \frac{2\pi f \, C X_c^2}{R} \rightarrow Q = \frac{\omega \cdot C \cdot X_c^2}{R} \rightarrow Q = \frac{\omega C \times \frac{1}{\omega^2 C^2}}{R}$$

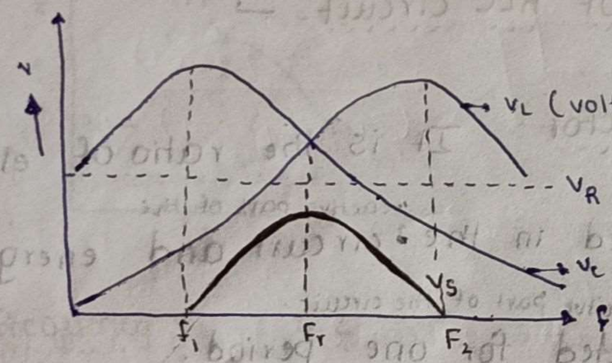
$\boxed{Q = \frac{1}{\omega C R}}$ for capacitive circuit $Q = \frac{X_C}{R}$

& resistive circuit.

* These formulas are confined to RLC Series circuit only.

* Note → $\boxed{Q = \frac{F_r}{B \cdot \omega}}$ Frequency (resonant) / Bandwidth

* Voltage vs frequency graph



V_S {voltage at combination of 3

* Admittance (Y) :- It is the reciprocal of impedance → $\boxed{Y = \frac{1}{Z}}$ units → mho (℧) or S (siemens)

$\boxed{Y = Z^{-1} \text{ or } \frac{1}{Z}}$, we know $Z = R + jX$

and here $\boxed{Y = G + jB}$

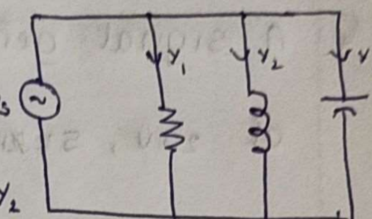
{ G = conductance = $\frac{1}{R}$, B = susceptance = $\frac{1}{X}$ }

* → $B_L = \frac{1}{X_L} = \frac{1}{2\pi f L}$ (inductive susceptance) → ℧

* → $B_C = \frac{1}{X_C} = 2\pi f C$ (capactive susceptance) → ℧

* → $B = \frac{1}{X}$ (susceptance) → ℧

1)* consider



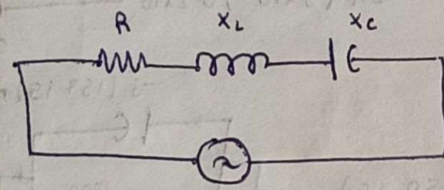
first branch admittance → Y_1

Second branch admittance → Y_2

third brandch admittance → Y_3

then equivalent admittance $\boxed{Y_T = Y_1 + Y_2 + Y_3}$

2)* Now



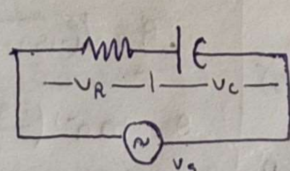
Here $Z = \sqrt{R^2 + (X_L \sim X_C)^2}$

then $Y = \sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{X_L} \sim \frac{1}{X_C}\right)^2} = \sqrt{\left(\frac{1}{R}\right)^2 + (B_L \sim B_C)^2}$

As, $Z = \frac{1}{Y}$, we get

→ $Z = \dfrac{1}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{X_L} \sim \frac{1}{X_C}\right)^2}}$

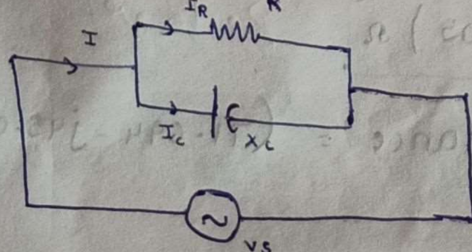
3)* Next



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

$\boxed{V_S = V_R - jV_C}$

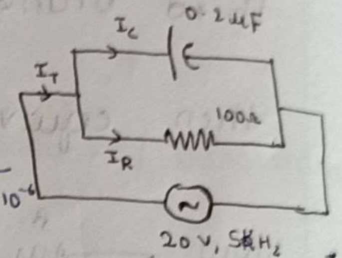
4)*



$I_T = \sqrt{I_R^2 + I_C^2}$

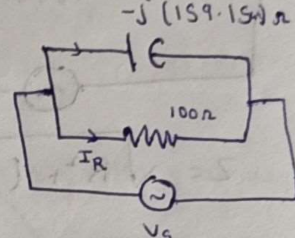
Q A signal generator supplies a sine wave of 20V, 5kHz to the circuit shown in figure

find The total current I_T, phase angle ϕ, total impedance of the circuit



A $X_C = \frac{1}{2\pi f c} = \frac{1}{2\pi (5\times10^3) 0.2\times10^{-6}}$

$X_C = 159.154\Omega$



$\frac{ab}{a+b}$

* $Z = \frac{(100)(-j159.154)}{(100-j159.154)}$

$100(a+jb)$

$100a+j100$

$\left\{\frac{1}{Z} = \frac{1}{R} + \frac{1}{X_C}\right\} = \left\{\frac{1}{Z} = \frac{1}{100} - \frac{1}{j(159.1549)}\right\}$

$-j159.15$

* $Z = \frac{0-j15915.49}{100-j159.1549}$

$a+jb \to R(\angle\theta)$

$R = \sqrt{a^2+b^2}$

$\theta = \tan^{-1}\left(\frac{b}{a}\right)$

Now $0-j15915$

$R = \sqrt{(-15915)^2} = 15915$

$\theta = \tan^{-1}\left(\frac{-15915}{0}\right) = 90^\circ$

$-90+57.85$

* $Z = \frac{15915.4\angle-90^\circ}{187.95\angle-57.85^\circ}$

* $Z = 84.67\angle(-90+57.85)^\circ$

* $Z = 84.67\angle(-32.15^\circ)\Omega$

* Total impedance = $84.67\angle-32.15^\circ$ polar
with ϕ

* $\boxed{Z = (71.694 - j45.05)\Omega}$ Rectangle

→ Now Total impedance = $(71.694 - j45.05^\circ)\Omega$

* $I_R = \frac{20}{100} = 0.2A$

* $I_C = \frac{20}{159.154\Omega} = 0.12\ A = 0.1256A$

$I_T = (0.2 - j\,0.125)\ A$

$I_T = \sqrt{0.2^2 + (0.125)^2}$

$\boxed{I_T = 0.23\ A} \sim \boxed{I_T = 0.2361 A}$

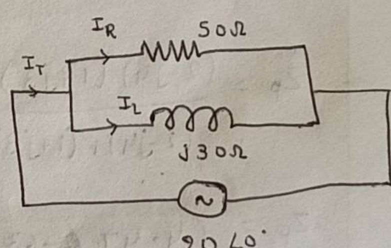
$Z = \frac{V}{I} = \frac{20}{0.2361} = \boxed{84.7}\ \cancel{84}\ 84.71\Omega$. {almost equal 84.67}

phase angle $\boxed{\phi = 32.15^\circ}$

Q A 50Ω resistor connected with

. Determine the total imped-ance and line current of the circuit.

A $Z_T = \frac{(50)(j30)}{(50+j30)} = \frac{0+j1500}{50+j30}$



$Z_T = \frac{1500\angle 90}{58.309\angle 30.96}$

$Z_T = 25.725\angle 90-30.96$

$Z_T = 25.725\angle 59.04^\circ$ {total impedance & ϕ}

1) $Z_T = (13.233 + j22.05)\ \Omega$ complex form.

2) $I_T = I_R + j I_L \rightarrow (1)$

$I_R = \frac{20\angle 0}{50\angle 0} = 0.4$ amp A

Substitute in (1)

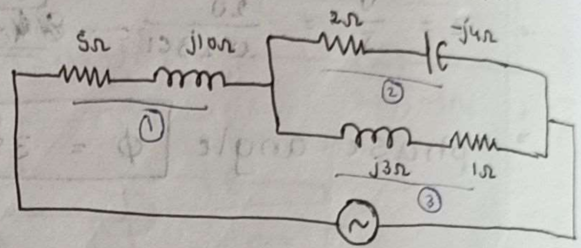
$I_L = \frac{20\angle 0}{30\angle 90} = 0.66\angle -90\ A$ (current lagging)

$I_T = 0.4 + j0.66$

$I_T = \sqrt{(0.4)^2 + (0.66)^2}$

$I_T = \underline{\underline{0.77A}}$ $\left\{ z = \frac{20}{0.77} \left\{ \frac{v}{i} \right\} = 25.9 \approx 25.72 \right\}$

Q Determine equivalent impedance of the circuit shown in figure.



S Consider

$Z_1 = (5 + j10)\Omega \rightarrow ①$

$Z_2 = (2 - j4\Omega) \rightarrow ②$

$Z_3 = (1 + j3)\Omega \rightarrow ③$

Now $Z_{parallel} =$ (② & ③ ||el) $\frac{Z_2 \times Z_3}{Z_2 + Z_3}$

$Z_P = \frac{(2-j4)(1+j3)}{(2-j4)+(1+j3)} = \frac{(2-j4)(1+j3)}{3-j}$

$Z_P = \frac{(4.47\angle -63.43)(3.16\angle 71.56)}{(3.16\angle -18.43)}$

$Z_P = \frac{14.125\angle 8.13}{3.16\angle -18.43}$

$Z_P = 4.47\angle 26.56\ \Omega$ {Impedance of parallel combination}

$= (3.998 + j1.99)\Omega$

$Z_T = (5 + j10)\Omega + (3.998 + j1.99)\Omega$

$Z_T = (8.998 + j11.99)\Omega$ //

* Calculate using admittance.

$$Y_2 = \frac{1}{2-j4} \longrightarrow ②$$

$$Y_2 = \frac{2+j4}{2^2-(j4)^2} = \frac{2+j4}{4+16} = \frac{2+j4}{20} = \frac{1+j2}{10} = \frac{1}{10} + j\frac{1}{5}$$

$$Y_2 = (0.1 + j0.2)\,\mho$$

$$Y_3 = \frac{1}{1+j3} = \frac{1-j3}{1^2+3^2} = \frac{1}{10} - j\frac{3}{10} =$$

$$Y_3 = (0.1 - j0.33)\,\mho$$

$$Y_P = Y_2 + Y_3$$

$$Y_P = (0.1 + j0.2)\,\mho + (0.1 - j0.33)\,\mho$$

$$Y_P = (0.2 - j0.1)\,\mho$$

$$Z_P = \frac{1}{0.2 - j0.1} \qquad \left\{ Z = \frac{1}{Y_P} \right\}$$

$Z_P = (4 + j2)\,\Omega$ almost same.

$Z_T = 1\,(15\,4\,j\,10)\,\Omega$

$$\rightarrow Y_T = \frac{Y_1 Y_P}{Y_1 + Y_P} \qquad \left\{ Y_1 = \frac{1}{5+j10} = \frac{5-j10}{125} = \frac{1}{25} - j\frac{2}{25} \right.$$

$$\left. Y_1 = 0.04 - j0.08 \right\}$$

$$\rightarrow Y_T = \frac{(0.04 - j0.08)(0.2 - j0.1)}{0.04 - j0.08 + 0.2 - j0.1}$$

wrong
don't read

$$\rightarrow Y_T = \frac{0.008 - j0.004 - j0.016 + 0.008}{0.24 - j0.18}$$

$$\rightarrow Y_T = \frac{0.016 - j0.020}{0.24 - j0.18} = \frac{0.026 \angle -51.30}{0.3 \angle -36.87}$$

$= 0.0866 \angle -14.43$

$= 0.084 - j0.022 \quad Z_T$ This also

$Z_T = \dfrac{1}{0.084 - j0.022}$

$Z_T = \dfrac{0.084 + j0.022}{}$ $\dfrac{0.3 \angle -36.87}{0.026 \angle -51.30}$

$Z_T = 11.53 \angle 14.43$

$Z_T = 11.166 + \angle 2.87$

$Z_T = 11.166 + j2.87$ almost okay.

---

* $Y_T = \dfrac{(0.04 - j0.08)(0.2 - j0.1)}{0.04 - j0.08 + 0.02 - j0.1}$

$Y_T = \dfrac{0.008 - j0.004 - j0.016 - 0.008}{0.24 - j0.18}$

$Y_T = \dfrac{0 - j0.020}{0.24 - j0.18} = \dfrac{0.02 \angle -90}{0.3 \angle -36.870}$

$Z_T = \dfrac{0.3 \angle -36.870}{0.02 \angle -90}$

$Z_T = 1.5 \angle 53.13$

$Z_T = 8.996 + j12.003$

* For RL series

$Z = R + jX_L$

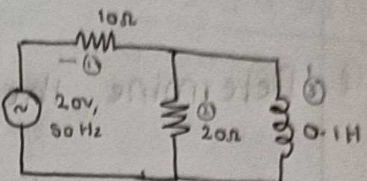
$Y = G - jB_L$

For RC series

$Z = R - jX_C$

$Y = G + jB_C$

Q For the circuit shown in figure, Determine the value of I_{total}, Z_{Total} and phase angle ϕ.



A $X_c = 2\pi f L = 2\pi(50)(0.1)$

$X_c = 31.41\,\Omega$

complex form $X_c = j31.41\,\Omega$

$$Z_p = \frac{20(j31.41)}{20+j31.41} = \frac{0+j628.2}{20+j31.41} = \frac{628.2\angle 90}{37.23\angle 57.51}$$

$Z_p = 16.87\angle 32.49$

$Z_p = 14.230 + j9.062$

$Z_T = 10 + (14.230 + j9.062)$

$Z_T = 24.230 + j9.062$

$Z_T = 25.86\angle 20.50$

* using admitance

$$Y_2 = \frac{1}{20} = 0.05\angle 0$$

$$Y_3 = \frac{1}{0+j31.41} = \frac{0-j31.41}{986.588} = \frac{31.41\angle 90}{986.588}$$

$Y_p = Y_2 + Y_3 = 0.05\angle 0 + 0.0318\angle 90$

$Y_p = \boxed{0.05}\ 0.0318\angle{-90}. = 0.05 - j0.0318 \rightarrow ①$

$$Y_T = \frac{1}{10} = 0.1\,℧ \rightarrow Y_T = \frac{(0.05-j0.0318)(0.1)}{0.1 + 0.05 - j0.0318}$$

$$Y_T = \frac{0.05 - j0.00318}{0.15 - j0.0318} = \frac{\cancel{0.008\angle 0}}{\cancel{0.100\angle -4}} = \frac{5\times10^{-3}\angle -32.45}{0.153\angle -11.96}$$

$Y_T = 0.0387\angle -20.49$

$Y_T = 0.036 - j0.013$

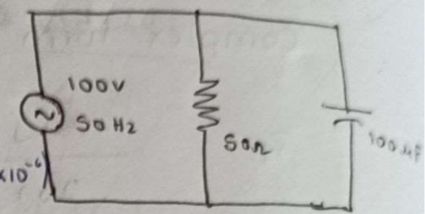
$Z_T = 0.153\angle -11.96 \quad 5.92\times10^{-3}\angle -32.45$

* $\phi = 20.50°$

* $I_T = \frac{V}{Z_T} = \frac{20}{25.868 \angle 20.50} = (0.773 \angle -20.50) A$

I lagging

Q Determine the impedance and phase angle of circuit shown in figure.



A $X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{1}{2\pi 50(100\times10^{-6})}$

$X_C = 31.830$

complex $= -j31.830$

Impedance $= \frac{50(-j31.830)}{50 \pm j31.830} = \frac{-j1591.5}{50 \pm j31.830}$

$= \frac{1591.5 \angle -90}{59.27 \angle -32.48} = 26.85 \angle -57.52$

$= \boxed{26.85 \angle -57.5 = Z}$ polar

→ $\boxed{Z = (14.418 - j22.65)\,\Omega}$ rect.

$\boxed{\phi = 57.5°}$ phase angle.

→ By admittance.

$Y_1 = \frac{1}{50} = 0.02$

$Y_2 = \frac{1}{-j31.83} = \frac{j31.83}{1013.14} = \frac{31.83 \angle 90}{1013.14} = 0.031 \angle 90$

$Y_2 = j0.0314$

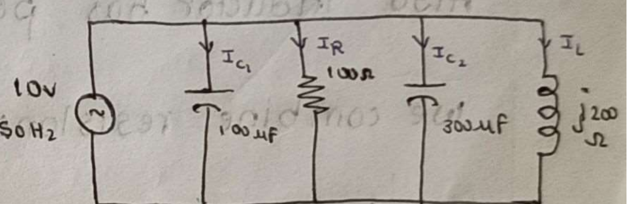
$Y_T = 0.02 + j0.0314$

$$Z_T = \frac{0.02 - j0.0314}{0.02 + j0.0314\,(0.02 - j0.0314)}$$

$$Z_T = \frac{0.02 - j0.0314}{0.0004 + 0.00098} = \frac{0.02 - j0.0314}{0.00138}$$

$$Z_T = 14.49 - j22.75$$ //

Q. For the parallel circuit shown in figure. Find the magnitude of current in each branch & what is the phase angle b/w applied voltage and current



A. $X_{C_1} = \frac{1}{2\pi f C}$

$= \frac{1}{2\pi(50)(100\times10^{-6})}$

$= 31.830\,\Omega$

$I_{C_1} = \frac{V}{X_C} = \frac{10}{31.830} = \boxed{0.314}$ A

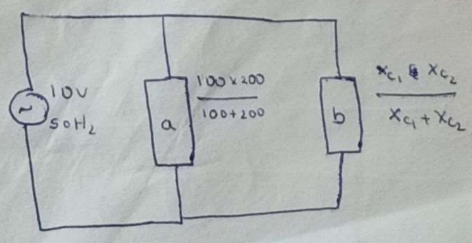
$I_R = \frac{V}{R} = \frac{10}{100} = \boxed{0.1\,A}$

$X_{C_2} = \frac{1}{2\pi(50)(300\times10^{-6})} = 10.61\,\Omega$

$I_{C_2} = \frac{V}{X_{C_2}} = \frac{10}{10.61} = \boxed{0.94\,A}$

$I_L = \frac{10}{200} = \boxed{0.05\,A}$

Now



$a = 66.66\,\Omega = \cancel{1/j}\,66.66\,\Omega$

$b = 7.963\,\Omega = -j\,7.963\,\Omega$

a & b are in parallel

$$z = \frac{ab}{a+b} = \frac{+66.66(-j7.963)}{+66.66 - j7.963} = \frac{-j530.813}{66.66 - j\,\tan^{-1}\frac{66.66}{7.963}} = \frac{530.813\angle -90}{67.134\angle -6.81}$$

$$z = \frac{\cancel{530.813\angle 0 + j\angle 0}}{\cancel{0\angle j\,58.6\,\angle 0}} = \frac{\cancel{530.813}}{\cancel{58.6\angle 90}} = \cancel{9.043}$$

As both the capacitors have -ve reactances, (-j) as we combine the reactance of them parallely.

Also inductor has positive reactance (+jx).

we combine resistance of resistor and reactance of inductor parallely.

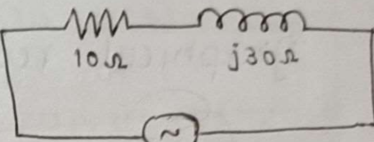
$$Z = \frac{530.813\angle -90}{67.134\angle -6.812} = 7.906\angle$$

ne circuit shown in figure, a voltage of

= 50 sin(ωt + 30) is applied. Determine the

power, reactive power and apparent

oer, power factor of given circuit



$v(t) = V_m \sin(\omega t + 0)$

t means, V_m passes at angle 0

e $v(t) = 50 \sin(\omega t + 30)$

, $V = 50 \angle 30^\circ$ $\{V_m = 50\}$ maximum voltatage

d $Z = 10 + j30 = 31.62 \angle 71.56^\circ$

w calculate I_{rms} or $(I_{eff}) = \frac{V_{eff}}{Z}$

$\frac{V_{rms}}{Z} = \frac{\frac{50}{\sqrt{2}} \angle 30}{31.62 \angle 71.56^\circ}$ $\left\{ V_{rms} = \frac{V_m}{\sqrt{2}} \right\}$

$I_{eff} = 1.118 \angle -41.56^\circ$

$I_{max} = I_{eff} \times \sqrt{2} = 1.118 \sqrt{2}$

$I_m = 1.58 \text{ A}$

$I(t) = I_m \sin(\omega t - 41.56) \text{ A}$

$I(t) = 1.58 \sin(\omega t - 41.56) \text{ A}$

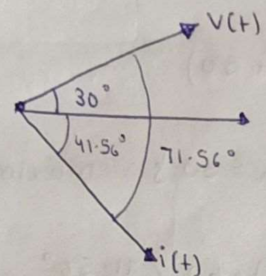
True power (or) Active power.

We know true power (P) = $V_{eff} I_{eff} \cos\phi$

$$P = \left(\frac{50}{\sqrt{2}}\right)\left(\frac{1.58}{\sqrt{2}}\right) \cos(71.56)$$

$$\boxed{P = 12.49 \text{ watts}}$$

Graphical representation of v(t) & i(t)



so $\phi = 71.56°$

② Reactive power

$$Q = VI \sin\phi$$

$$Q = \frac{50}{\sqrt{2}}\left(\frac{1.58}{\sqrt{2}}\right) \sin(71.56)$$

$$\boxed{Q = 37.47 \text{ VAR}}$$ {volt Ampere Reactive power}

③ Apparent power:

$$S = VI$$

$$S = \frac{50}{\sqrt{2}}\left(\frac{1.58}{\sqrt{2}}\right)$$

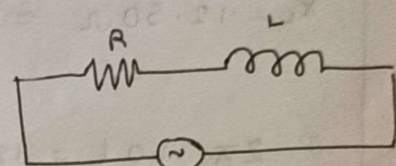
$\boxed{S = 39.5}$ → VA {volt ampere}

(or) ⇒ $S = \sqrt{P^2 + Q^2}$, we get same value.

$\boxed{S = 39.49 \text{ VA}}$

(4) Power factor → $\cos\phi = \cos(71.56) = \boxed{0.316}$ lag

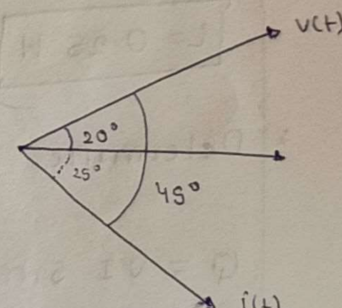
Q Determine the circuit constants for the network shown in figure, if the applied voltage to the network is $v(t) = 100\sin(50t + 20^\circ)$. The true power in the given network is 200 watts and the power factor is 0.707 lagging



A $v(t) = 100\sin(50t + 20)$.

$V = \frac{100}{\sqrt{2}} \angle 20^\circ$ volts

$P = 200\,W$ (given)



$PF = \cos\phi = 0.707$ lag.

$\phi = \cos^{-1}(0.707) = 45^\circ$

$P = VI\cos\phi$

$I = \frac{P}{V\cos\phi} = \frac{200}{\frac{100}{\sqrt{2}}(0.707)}$

$I = 4$ Amp {Here $I = I_{rms}$ or I_{eff}}

$I_m = I_{rms} \times \sqrt{2}$

$I_m = 5.685$ Amp

$i(t) = 5.65\sin(50t - 25^\circ)$ A

we know $Z = \frac{V}{I}$

$$Z = \frac{(100/\sqrt{2}) \angle 20}{(5.65/\sqrt{2}) \angle -25^\circ}$$

$$Z = 17.69 \angle 45^\circ \ \Omega$$

$$\boxed{Z = (12.50 + j12.50)\ \Omega}$$

$$\boxed{R = 12.50 \Omega}$$

$X_L = 12.50 \Omega = \omega L = 2\pi f L$

$= 2\pi\ 50 L = 12.50$ $\{\omega = 50 \text{ given}\}$

$= L = \frac{12.50}{50}$

$$\boxed{L = 0.25\ H}$$

* Determine reactive & apparent power for same circuit

$Q = VI \sin\phi$

$Q = \frac{100}{\sqrt{2}} \left(\frac{5.65}{\sqrt{2}}\right) \sin 45^\circ$

$Q = 200$ VAR (Reactive)

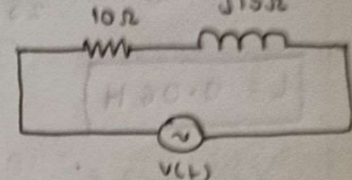
$S = VI = \frac{100}{\sqrt{2}} \cdot \frac{5.65}{\sqrt{2}}$

$S = 282.84$ VA {Apparent}

complex form of $S = P + jQ$

$$\boxed{S = 200 + j\ 200}$$

Q A voltage of $v(t) = 150 \sin(250t)$ is applied to the circuit shown in figure, determine the power delivered to the circuit and the value of inductance in Henry.



A
$v(t) = 150 \sin 250t$

$V_m = 150V,$

$\omega = 250,$

$V_{rms} (v) = \frac{150}{\sqrt{2}} \angle 0$

$V = 106.06 V$

and $Z = 10 + 15j$

$\rightarrow Z = 18.02 \angle 56.30 \Omega$

$\rightarrow I = \frac{V}{Z} = \frac{\frac{150}{\sqrt{2}} \angle 0}{18.02 \angle 56.30}$

$I = 5.88 \angle -56.30 \ A$ $\{ I_m = 5.88 \times \sqrt{2} = 8.31A \}$

~~{ i(t) = 5.88 sin~~

$\phi = 56.30$ $\rightarrow i(t) = 8.31 \sin(250t - 56.30) A$

$\cos\phi = \cos(56.30) = \boxed{0.55 \text{ lag}}$

①* Power delivered or average power = $VI\cos\phi$

$P = VI \cos\phi$

$P = \frac{150}{\sqrt{2}} \times \frac{8.31}{\sqrt{2}} \cos(56.30)$

~~P' = 242~~

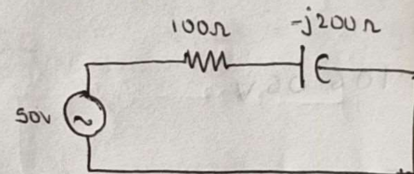
$$\boxed{P = 345.80 \text{ watts}}$$

$X_L = \omega L \qquad \{\omega = 250\} \;\&\; X_L = 15\,\Omega$

$$L = \frac{X_L}{\omega} = \frac{15}{250}$$

$$\boxed{L = 0.06\,H}$$

Q Determine the power factor, true power, reactive power and apparent power of given circuit.



A $Z = 100 - j200\,\Omega$

$Z = 223.6 \angle -63.43°$

$\phi = 63.43°$

power factor $\cos\phi = \cos(63.43) = \boxed{0.44 \text{ lead}}$

$I = \dfrac{V}{Z} = \dfrac{50}{223.6} = 0.223\,A$

True power $= VI\cos\phi$

$P = (50)(0.223)(0.44)$

$\boxed{P = 4.9067 \text{ watts}}$ (or) $P = I^2R$

Reactive power → $Q = VI\sin\phi$

$Q = (50)(0.223)\sin(63.43)$

$\boxed{Q = 9.97 \text{ VAR}}$

also $Q = I^2 X_C = (0.223)^2 (200)$

$\boxed{Q = 9.945}$

Apparant power $S = VI$

$S = 50(0.223) = \boxed{11.15 \text{ VA}}$

also $S = I^2 Z \rightarrow (0.223)^2 (223.6)$

$\boxed{S = 11.119 \text{ VA}}$

also $S = \sqrt{P^2 + Q^2}$

Q In a certain RC circuit, the true power is 300 watts and the reactive power is 1000VAR. What is the apparent power. & power factor.

A $P = 300 \text{ W}$

$Q = 1000 \text{ VAR}$

$S = \sqrt{P^2 + Q^2}$

$S = \sqrt{300^2 + 1000^2}$

$\boxed{S = 1044.03 \text{ VA}}$

$P = S \cos\phi$ $\{S = VI\}$

$\cos\phi = \frac{P}{S} = \frac{300}{1044.03}$

$\boxed{\cos\phi = 0.287 \text{ Lead}}$